

MACHINERY.

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THE PARIS EXPOSITION OF 1900.

A DESCRIPTION OF SOME OF ITS GENERAL FEATURES.

ANDREW D. FULLER.

In the beautiful Salle des Fêtes, April 14th, 1900, France opened its fifth international exposition held at Paris since 1850. During the past six years the work had been pushed steadily onward until a few days before the opening, when by an extra effort and the help of the military forces, most of the perquisites of construction were made to disappear, leaving the buildings and grounds in all their attractiveness. The executive head of the Exposition has had the able assistance of M. Alfred Picard, the Commissioner General, and the other members of the Exposition Commission. At the beginning it was estimated that the project would cost about 100,000,000 francs (\$20,000,000). The Government appropriated 20,000,000 francs, and the Municipality of Paris agreed to contribute a like sum on condition that

at the close of the Exposition, November 5th. As no tickets are sold at the gates, one must purchase them in the shops or from the venders who swarm about each entrance. It is forbidden to sell them for more than one franc. The immense number issued (65,000,000) makes it possible to get tickets for about one-half a franc or ten cents. From 8 to 10 in the morning and 6 to 10 in the evening two tickets are demanded.

The exposition proper, covering about 270 acres in the heart of the city, is divided into two principal sections, viz.: the Champ de Mars and Trocadero Palace and Gardens and the Esplanade des Invalides which is connected with the large area between the Champs-Élysées—formerly the site of the Palais de l'Industrie—by the handsome new bridge named in honor of Alex-



Fig. 1. General View of the Exposition. In the foreground is a section of the Trocadero Gardens, where are located the buildings of the foreign colonies. Crossing the river Seine, in the foreground, is the Jena Bridge. Beyond the Eiffel Tower is the Champ de Mars, at the extreme further end of which is the Palace of Electricity, where most of the machinery exhibits are placed. A plan of the Champ de Mars is shown on page 292.

the Exposition would be held within the city limits. The remaining 60,000,000 francs were raised by an issue of 3,500,000 Bons de l'Exposition, backed by a combination of the solid French banking houses. Every bond bears twenty admission tickets of a face value of one franc each. The holder is also entitled to a chance in a series of quarterly lottery drawings, a considerable reduction in transportation on the French railways or a twenty-five per cent. discount on admission charged by the various attractions authorized within the grounds. Of the 65,000,000 francs raised in this manner, 5,000,000 was estimated as the cost of printing, advertising, etc., in connection with the bond issue. It is estimated that the income from the various concessions granted for amusements, restaurants, tobacco, news, flower stands, etc., will leave a profit of about 10,000,000 francs

under III. of Russia. These two divisions are joined by the picturesque buildings and grounds reared on either side of the Seine, together with several new foot bridges erected for the occasion. Nearly one-half of the whole area has been built upon. In addition to this area there is at Vincennes, not far without the fortifications which encircle the city, an annex of some 275 acres, about six miles from the main buildings, where the races and athletic contests will be held. There also are found interesting transportation and machinery exhibits. Of the buildings used in former expositions, the Trocadero Palais, the Tour Eiffel and the Palais des Machines now renovated for the display of Agriculture and Food Products on either side of the Salle des Fêtes, in which all ceremonies are intended to take place, are the only ones retained. The Grand and the Petit

Palais des Beaux Arts, constructed near the Champs-Élysées in place of the Palais de l'Industrie, will be a worthy monument to the Exposition of 1900.

The exhibits are divided into eighteen general groups as follows: 1, Education and Instruction; 2, Works of Art; 3, Literature, Science and Art appliances and processes; 4, Mechanical Engineering; 5, Electricity; 6, Civil Engineering and Transportation; 7, Agriculture; 8, Horticulture and Arboriculture; 9,

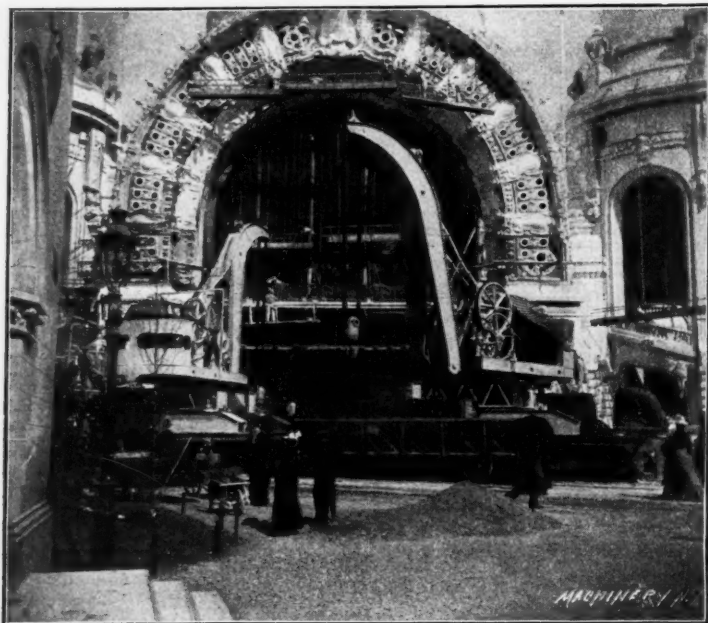


Fig. 2. Entrance to the Palace of Mines, showing two Grue Electric Cranes for handling heavy mining exhibits. Twenty-five tons capacity.

Forestry, Sport, Fishing, Wild Crops; 10, Food Products; 11, Mining, Metallurgy; 12, Decoration and Furniture of Public Buildings and of Dwelling Houses; 13, Thread, Yarns, Textile Fabrics, Clothing; 14, Chemical Industries; 15, Various Industries; 16, Social Economy, Hygiene, Public Charitable Relief; 17, Colonization; 18, Army and Navy. In devising the 121 classes which make up these groups it has been intended to have the exhibits follow in logical sequence, the products of all countries being displayed in such proximity that comparisons are



Fig. 3. Jena Bridge over the Seine, looking towards Trocadero Palace.

easily made. This arrangement will be appreciated by those who visit the Exposition with instructive motives, and will be of unrealized benefit to those who seek amusement rather than education. Each group has a building and often a small annex in the immediate neighborhood. The buildings in the Champ de Mars are joined to make one grand building about the three sides of the tastily arranged central garden. At the open end stands the Tour Eiffel erected to a height of 300 meters at a cost of one million dollars.

Mechanical Engineering, Electricity, Civil Engineering, Transportation, Mining and Metallurgy, the groups of especial in-

terest to readers of MACHINERY, are all located in the Champ de Mars. The Palais de l'Electricite extends the entire width of the Champ de Mars forming the background for the Château d'Eau, a grand waterfall from which about a million and a half gallons of water per hour fall one hundred feet toward the broad basin below. The weird effect produced on the water by many colored electric lights is one of the evening features. Both ends of the electricity building are occupied by the huge power machines of different countries and a multitude of machines exemplifying the mechanical industries. An interesting portion of the Civil Engineering and Transportation Building is the artistic frieze, depicting transportation from the most ancient times to



Fig. 4. Bridge Alexander III. over the Seine, near the Palace of Fine Arts.

the present, adorning the length of its facade. International expositions have now grown so large that weeks are necessary to thoroughly inspect the exhibits of even a few selected groups. Easy access is had between the two principal sections by a circuit electric railway of the third rail type two miles in length, or by a moving platform which parallels the electric road and



Fig. 5. Buildings of Greece, Sweden and Monaco. Greece, low building at the right; Sweden in the center, and Monaco, at the left.

travels in the opposite direction at the rate of two and one-half miles an hour for the first platform and five miles an hour for the second.

The principal amusements are located along the Seine and in the Trocadero Gardens where the Colonial section exhibits all the picturesqueness of the life and habits of foreign lands.



Fig. 6. The "Grand Palais" of Fine Arts. Fig. 7. Bridge Alexander III., with the "Petit Palais" in the distance. Fig. 8. The "Petit Palais" of Fine Arts situated opposite the "Grand Palais."

THREE ARTISTIC FEATURES OF THE EXPOSITION.

MECHANICAL FEATURES OF THE EXPOSITION.

THE EXHIBITS AT CHAMP DE MARS AND VINCENNES BUILDINGS.

WARREN E. WEINSHEIMER.

The principal portion of the Palace of Electricity, where are installed the large engines and dynamos, consists of a long, narrow strip, 400 x 50 meters, extending across the Champ de Mars, north of the Palace of Agriculture, which is at the extreme southern end of the Champ de Mars, and was used in the

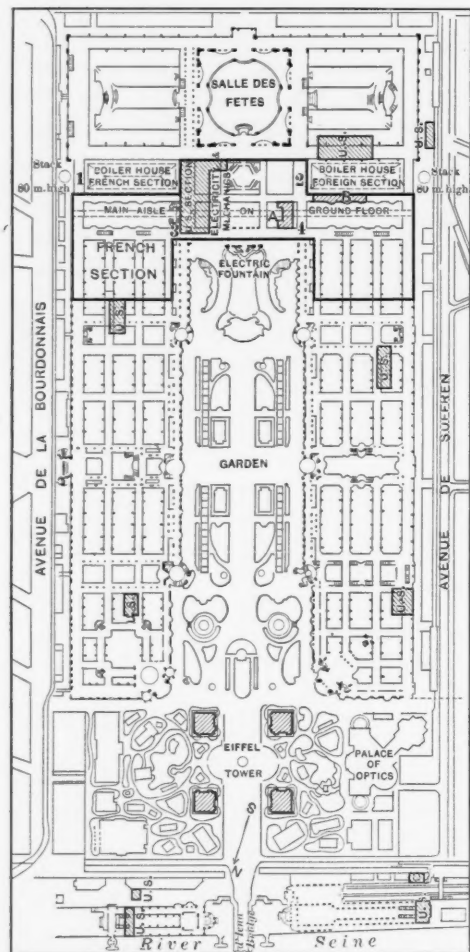


Fig. 1. Plan of the Champ de Mars where are located most of the Engineering Exhibits. The Palace of Electricity is at the upper end. The shaded portion of this building is the United States section, and is shown in Plan in Fig. 2.

exposition of 1889 for the Machinery Hall. There is a space of 40 meters between these two buildings where are located the boilers. As will be seen by the plan, the Palace has two wings extending along the Champ de Mars on both ends. These wings are devoted to smaller machines, as tools, gas engines and general machinery.

The French have reserved the east wing and the corresponding portion of the building, about 40 per cent., for themselves, and the remaining 60 per cent. is divided proportionally among the foreign nations. The Main Palace has a gallery 14 meters wide running around the entire building with a broad transverse gallery in the middle called the Salon d'Honneur, where are located the retrospective exhibits. This leaves two large light wells at either end, making a fine place for the traveling cranes and large engines which extend above the level of the gallery.

Starting with the two boiler houses, indicated in Fig. 1 and one of which appears in Fig. 3, one observes that they are roofed structures of corrugated iron and skylight 120 x 32 meters long and 32 meters wide. There are two immense chimneys

for the boilers, one at the outer end of each house. These chimneys are built of brick of various colors, making a beautifully ornamental effect. They are 80 meters high, 8 meters exterior diameter and 6 meters interior diameter. The chimney is connected with the boilers, which are arranged in two rows, by an underground flue running two meters underneath the 5 meter aisle between the rows of boilers. The fuel used is soft coal and is brought in on the track in the middle of this aisle. The front of the boilers where the firing is done presents an interesting view, there being a distance of 7.5 meters to the adjacent buildings from which to see them in operation, also the feed pumping devices. The steam from these boilers are taken to two large headers and from there are distributed to the different engines through underground tunnels. In back of these two headers, which are located on the 7.5 meter aisle facing the Electricity building, are two large stacks two meters square and extending to the top of the boiler house roof, for taking away any escaping steam in the tunnels and also ventilating the same. Steam is furnished at 100 pounds pressure, and, with the 50 boilers, represent about 15,000 H. P., or for both boiler houses, a total of 30,000 H. P.

In the French section boiler house are six boilers of Rosior, of St. Denis, Seine. Next to these are three from Compagnie De Fives, of Lille. Then there follow 6 from A. Montupet, of Paris; 1 from Solignac, Grille & Cie, Paris; 1 from Bietrix, Le-flaive, Nicolet & Cie, of St. Etienne, and to finish the row on the right are 6 from De Maeyer & Cie, of Proung. On the other side is a large battery of 16 from Babcock & Wilcox, showing their different types, and finally 12 boilers from J. & A. Niclausse, of Paris. All these boilers, with the exception of the Babcock & Wilcox, are down-draft return tubular boilers.

Entering the Palace of Electricity one should first mount the grand staircase for a bird's-eye view. The most prominent features are the two immense cranes seen in Figs. 4 and 5. Fig. 4 shows the cantilever crane in the French section running on tooth tracks placed on either side of the main aisle. This crane was built by Jules Le Blanc, of Paris, and is arranged to revolve on a circular track on top of pedestal. The engines are all direct-connected to generators and vary from 2,000 to 5,000 H. P.

Fig. 5 shows the foreign section with the large truss crane built by Carl Flohr, of Berlin, Germany. This view is also look-

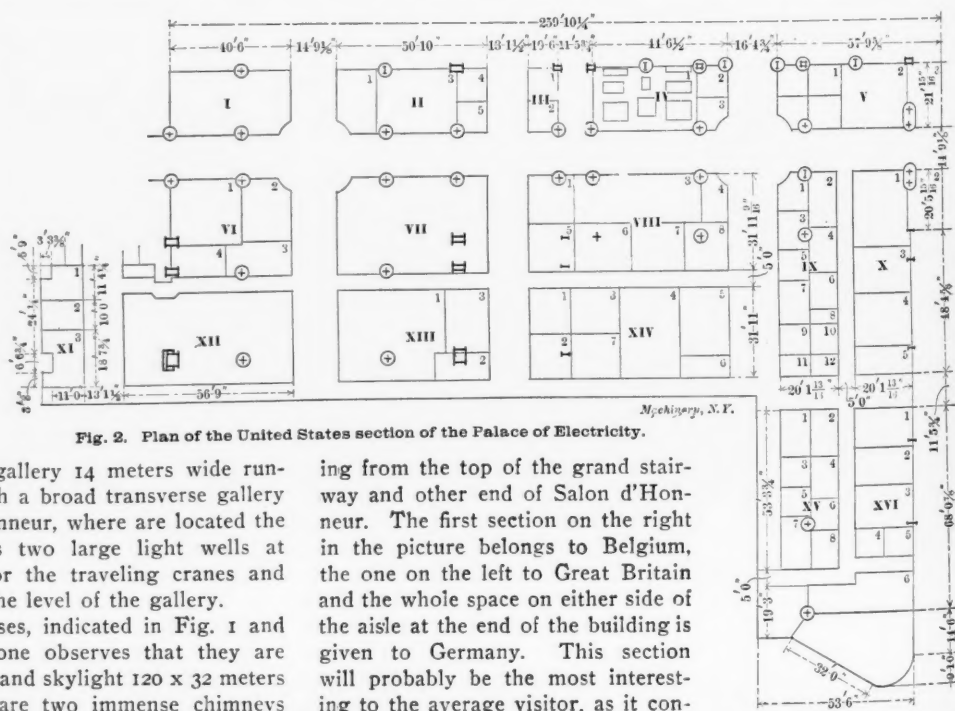


Fig. 2. Plan of the United States section of the Palace of Electricity.

ing from the top of the grand stairway and other end of Salon d'Honneur. The first section on the right in the picture belongs to Belgium, the one on the left to Great Britain and the whole space on either side of the aisle at the end of the building is given to Germany. This section will probably be the most interesting to the average visitor, as it con-

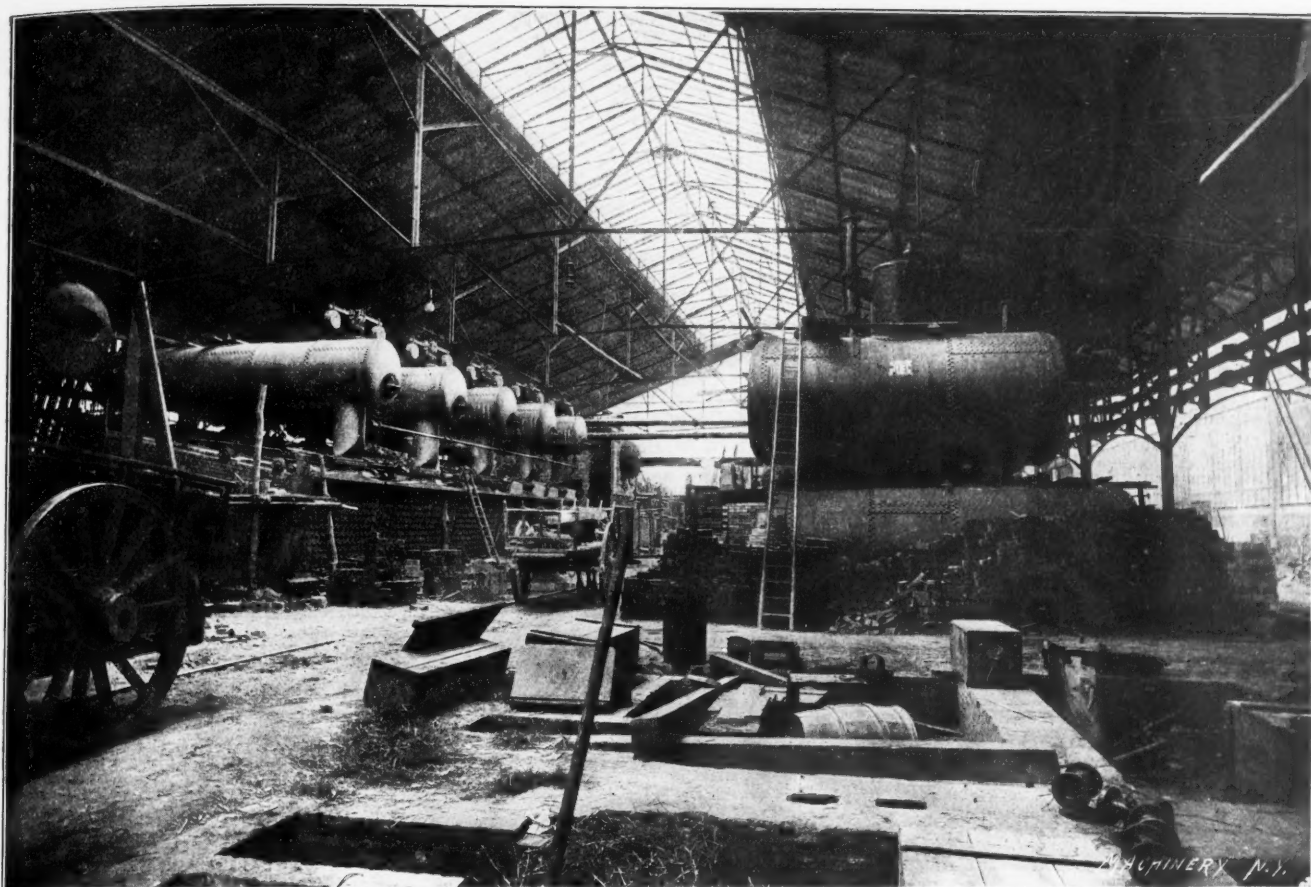


Fig. 3. Interior View of the Foreign Section Boiler House of the Palace of Electricity, looking from Point 2 in the plan. There is another boiler house of the same size and construction devoted to French boilers.

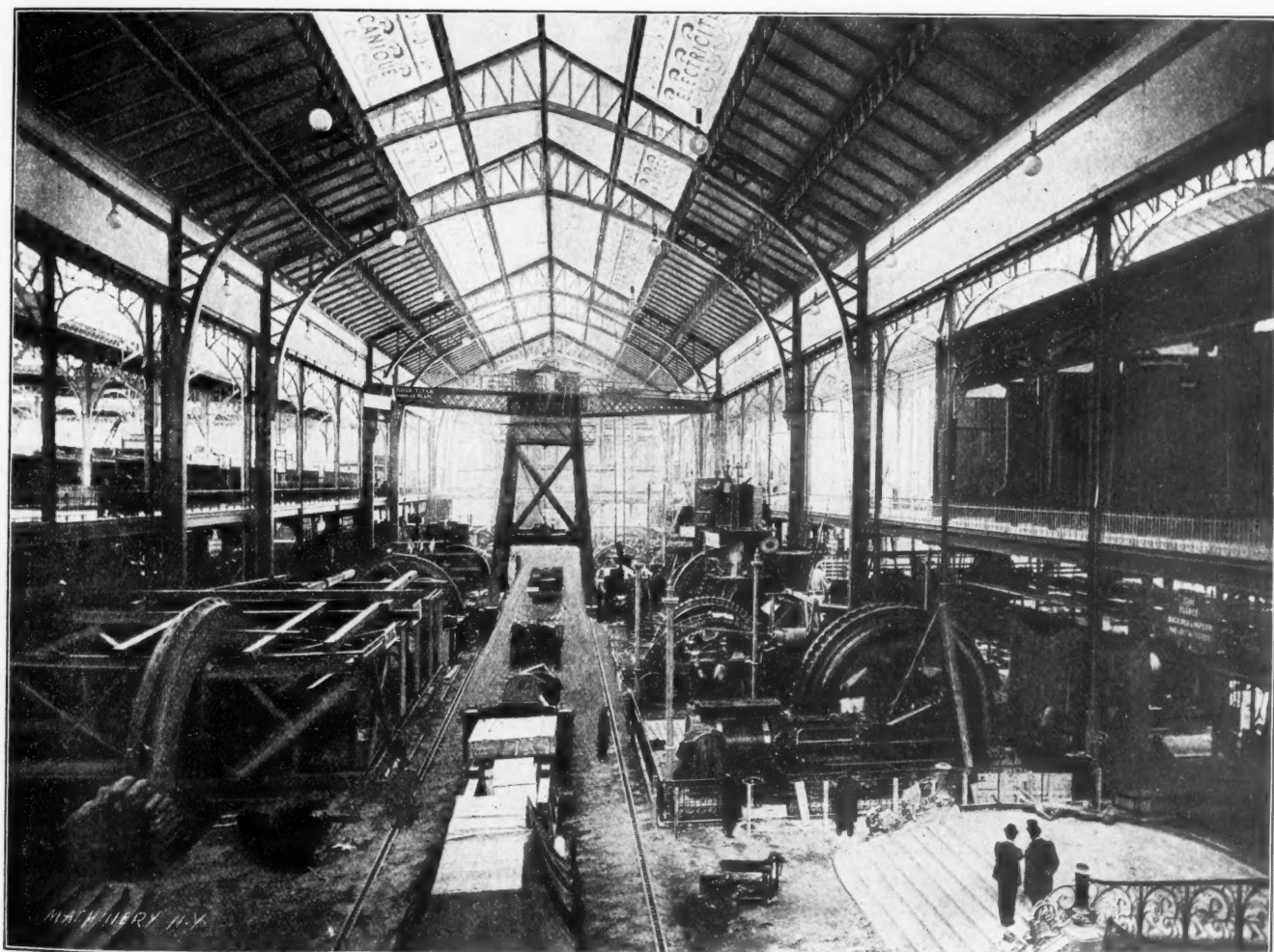


Fig. 4. Interior of the Palace of Electricity, looking from Point 3 in the plan. The Cantilever Traveling Crane is of French manufacture.

tains the largest engines, a closer view of which is shown in Fig. 6. The engine on the left, Fig. 6, is from Vereinigte, Maschinenfabric, Augsburg, and Maschinenbangesellschaft, of Nuremberg, direct-connected to a generator of Helios Elektricitats of Kohn, and is a four-cylinder compound engine of 6,000 H. P. Next to this is a 1,500 H. P. two-cylinder compound vertical engine from Lahmeyer & Co., from Frankfurt-on-Main. The engine on the right in the corner is a 5,000 H. P. three-cylinder triple expansion marine engine from Schuckert & Co., Nuremberg. The next is a 2,500 H. P. triple expansion engine from A. Borsig, of Berlin, connected to a Siemens & Halske generator.

As will be seen by the photographs, the gallery is used for installing the small apparatus and devices of machinery and electricity. Fig. 6 shows a fine exhibit from Schaffer & Budenberg, of gages, calorimeters, etc., and from Siemens & Halske, of electrical apparatus. The larger machine tools, such as lathes, planers and drilling machines are on the ground floor. Fig. 5 shows a fine exhibit of this from Chemnitz, also general machinery, as shafting, pulleys, etc., from Maschinenban, Act, Ges Dessan, Berlin. J. E. Reinecker has a large exhibit of lathes, etc.



Fig. 5. Interior of Palace of Electricity viewed from the end opposite to that in Fig. 4, or from Point 4 in the Plan. A German Traveling Crane appears in the Foreground.

In the English section there are two engines, one from Robey & Co., Limited, and a triple expansion engine from Willans & Robinson, of Rugby, England.

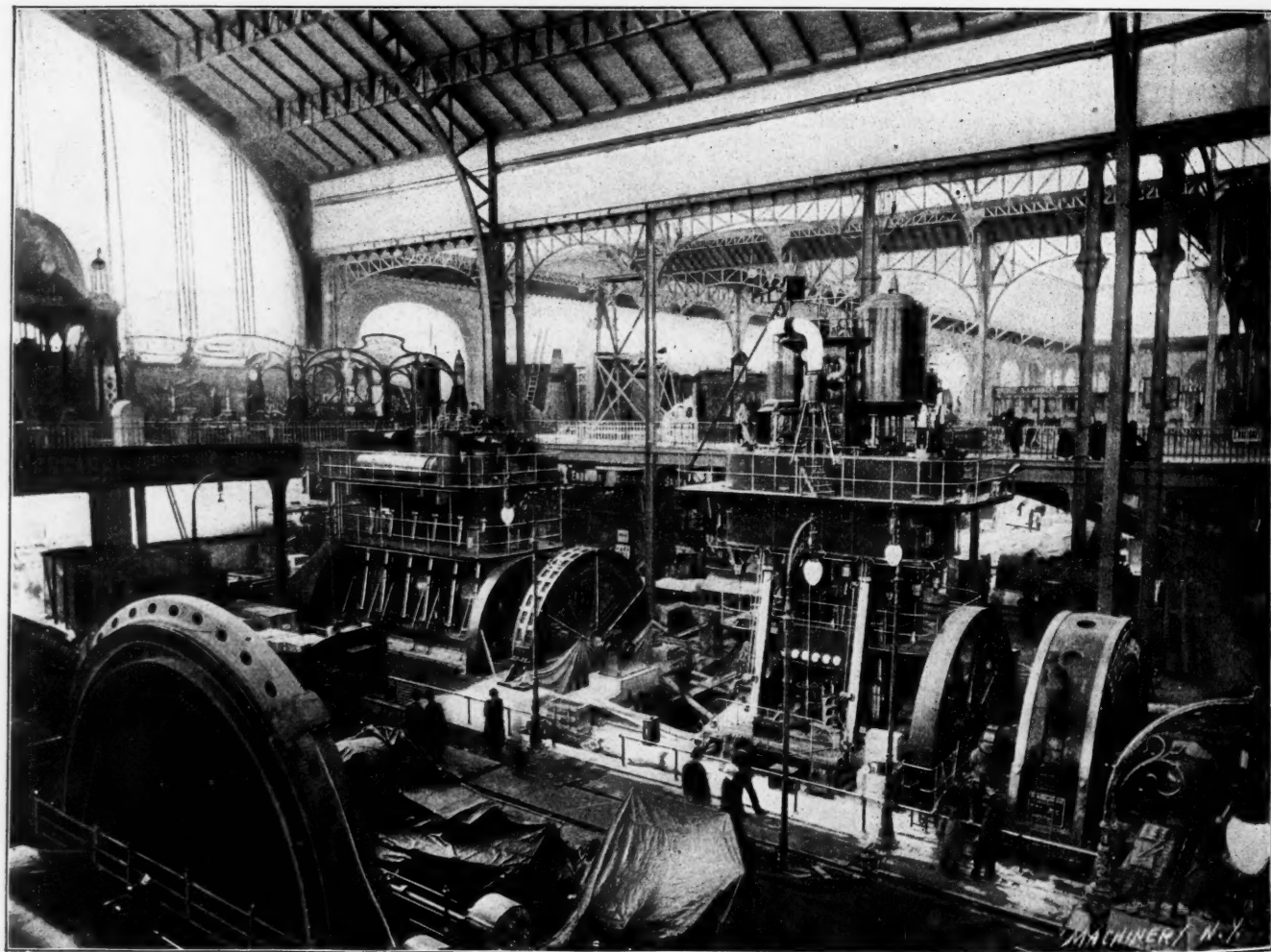


Fig. 6. Large Engines in the German Section of the Palace of Electricity.

The Belgian section has a very interesting engine, two-cylinder compound, 3,000 H. P., from Carles Freres, of Ghent.

UNITED STATES MACHINERY BUILDING AT VINCENNES.

The United States Machinery Building was designed with the idea to represent a model American machine shop where the visitors could see every variety of American machine tools in operation. Fig. 7 shows the front elevation of this building, which is composed of a main building 350 feet long, and 76 feet wide, and an annex 225 feet long and 48 feet wide. The framework is constructed of steel from the Carnegie Works and was erected by the Berlin Iron Bridge Co., in eight days and by 14 Ameri-

The temporary engine is a four-cylinder 200 H. P. vertical Willans type, connected to a 150 K. W. 220 volts bipolar shunt-wound Crompton dynamo. Besides this engine there are three large air compressors supplying 2,500 feet of air per minute at 150 pounds pressure, running 15 exhibits, including pneumatic tools and small steam engines required to exhaust into the shop, also all the air for the locomotives for the English and American sections.

Electrical transmission is adopted throughout the shop and wiring is carried out according to a most approved method of shop wiring. The unloading of cars was taken care of by the

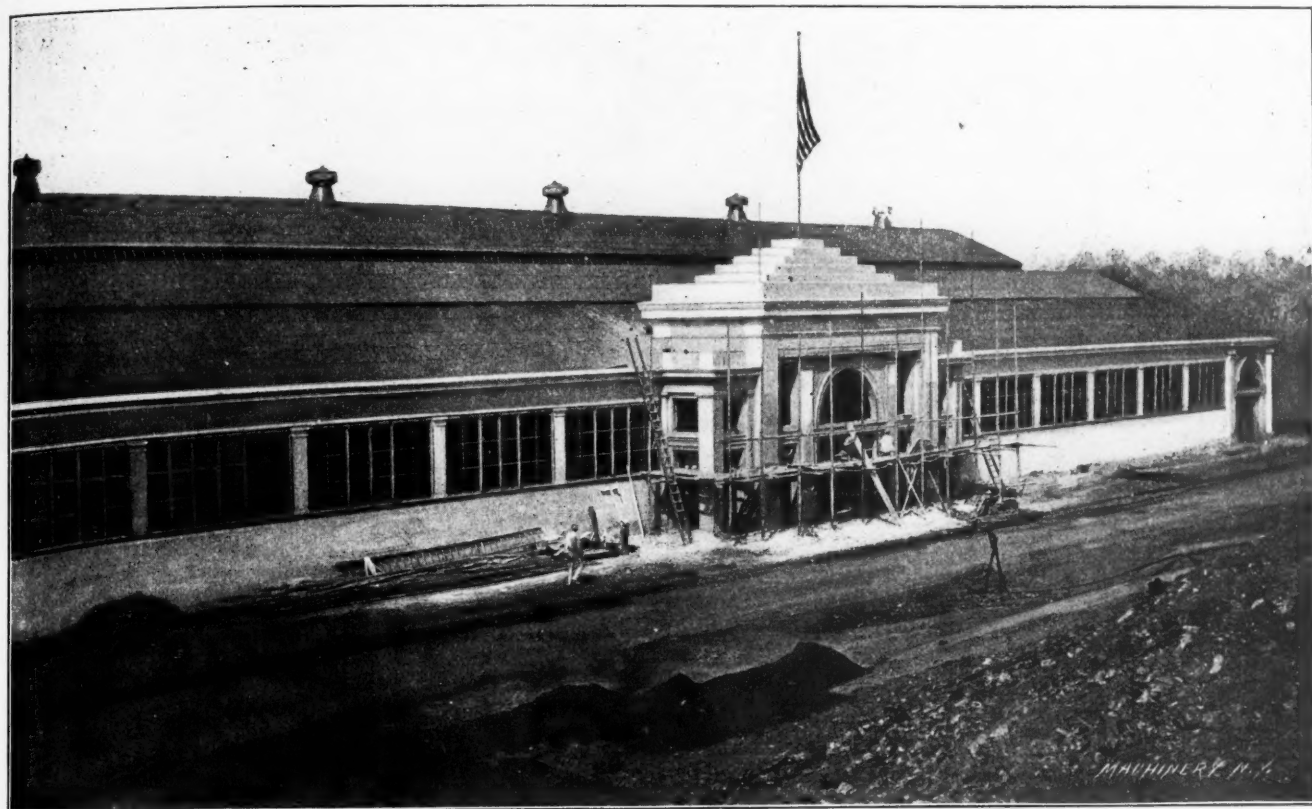


Fig. 7. United States Machinery Building at Vincennes---The American Machine Shop equipped throughout with American Tools.

can workmen. In addition to the machine tools, this building contains in the annex the cotton gins, a large cotton compress machine and mining machinery such as air compressors, rock drills, etc.

Power is furnished by two 250 H. P. Morrin Climax boilers which are fed by a Blake pump and Lee injector, the piping being so arranged that either pump or injector may be used and the supply taken from cold water mains or hot well, also through or around the exhaust steam feed water heater.

The steam engine plant consists of a 300 H. P. tandem compound Ball engine, direct-connected to a 200 K. W. 220 V. compound-wound multipolar Bullock Electric Co. generator. This furnishes current for the motors of the various exhibitors and also for the 30-ton Shaw electric crane. Three weeks before the opening of the Exposition, the Pauillac with engine crankshaft and generator on board was given up as lost. A temporary engine and dynamo were ordered from the Westinghouse Co. of Havre, and this was put in place and was the only engine that ran on the opening day.



Fig. 8. Interior of Vincennes Building during the Installation of the Machinery.

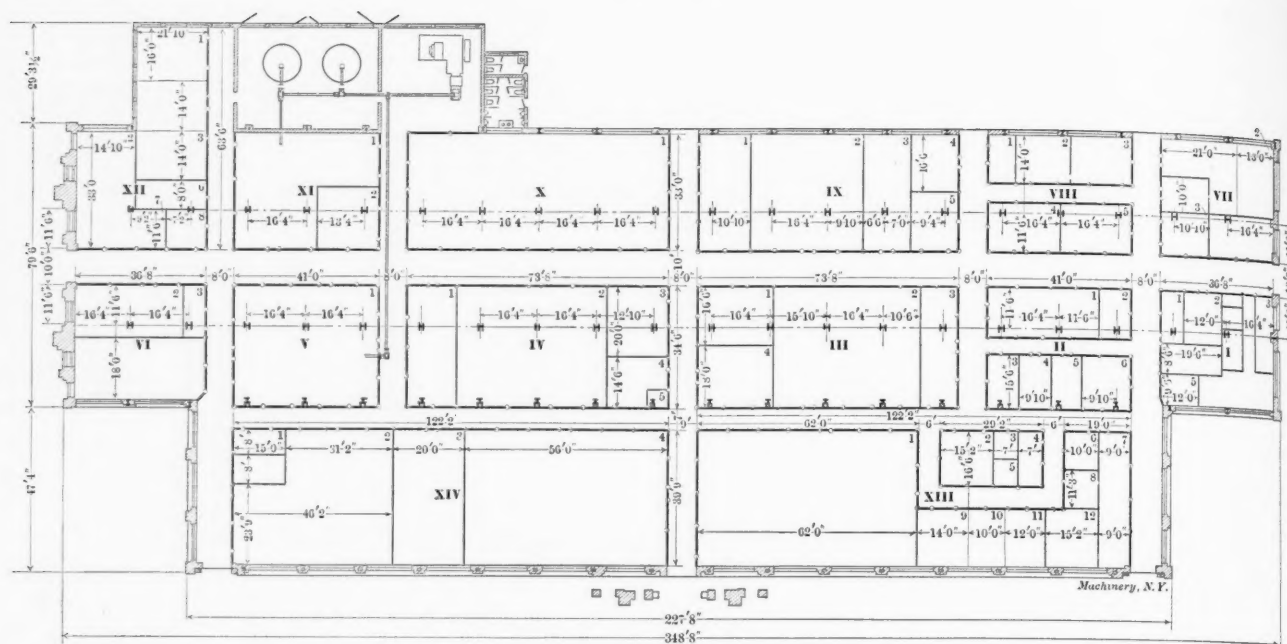


Fig. 9. Plan of the American Machinery Exhibit at Vincennes. The reference numbers of this cut and of the one shown on page 292 will enable one to find the locations of the various exhibits referred to in the Supplement.

electric crane. The charge being actual cost by the ton hour. This figure was computed from data taken for 15 days, including total ton hour service for each exhibitor and all expense and cost for power.

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HAND AND POWER FEED MILLING MACHINE.

The illustration shows the Fox No. 3 hand and power milling machine which is a tool specially designed for light and medium

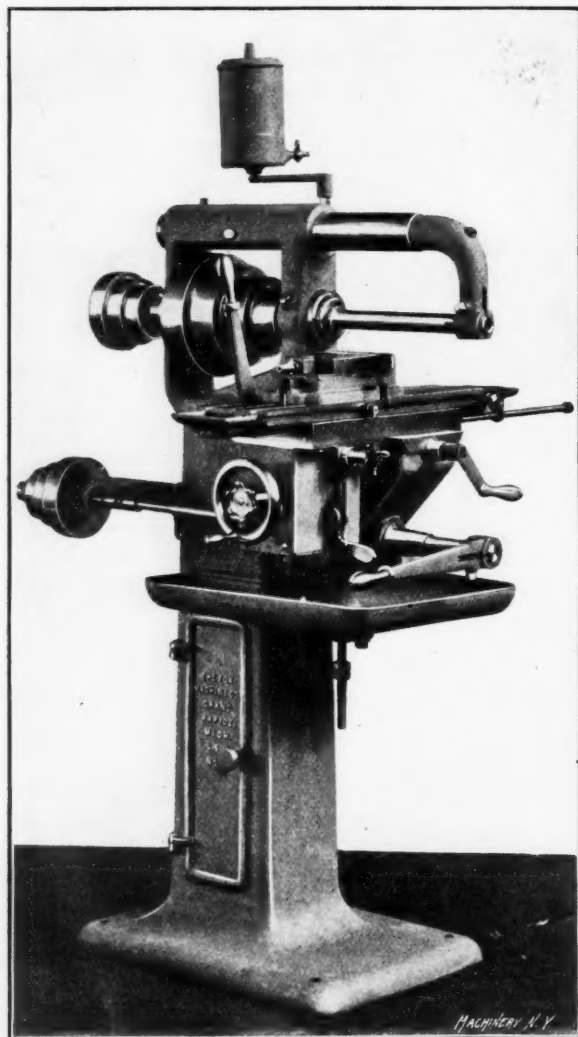


Fig. 1. The Fox Hand and Power Feed Milling Machine.

manufacturing. It has the advantages of the hand feed milling machine together with that of the power feed machine, as it

possesses a hand rack feed, a hand screw feed and a power screw feed. The feed can be started or stopped while the machine is in operation or can be reversed by slightly turning the star wheel shown in front of the hand-wheel. As will be understood the combination of hand and power feeds gives the advantage of a quick return to the platen when the feed is disengaged, as the platen is returned by one movement of the hand lever. The knee and saddle are counter-balanced by a weight inside of the column so that a free and easy action is obtained for hand feeding.

The spindle boxes are made of bronze boxes which have a form of adjustment that allows the wear to be compensated both horizontally and vertically. This is effected, as shown in Fig. 2, which shows the box divided into three parts and the upper sections provided with set screws for taking up the wear. The spindle is bored for Brown & Sharpe No. 9 taper. The distance between the spindle center and the overhanging arm is $4\frac{1}{2}$ ". The platen is $6" \times 24"$ and has a longitudinal movement of $17\frac{1}{4}"$.

The weight of the machine complete with a two-speed countershaft is about 640 pounds. It is manufactured by the Fox Machine Co., Grand Rapids, Mich.

* * *

SHOULD HAVE BEEN A POET.

A reporter in describing a new Western shop recently, said: "One of the new machines is a twelve-foot open-side De-trick & Harvey iron planer. It weighs 13,500 pounds and is so arranged that it can plane a piece of iron on the top and on the side at one and the same time. It works with the utmost regularity, planing off thick iron shavings as easily as a carpenter's plane turns up the curling pine shavings that little children love to wear in imitation of an old maid's curls."

This is quite sentimental, if true; but hardly less so than his description of the foundry, where the molten iron reminded him of the "red cranberry sauce that grandmother used to pour out into molds to harden."

* * *

One boiler horse-power equals 34.5 pounds of water evaporated from and at 212 degrees per hour.

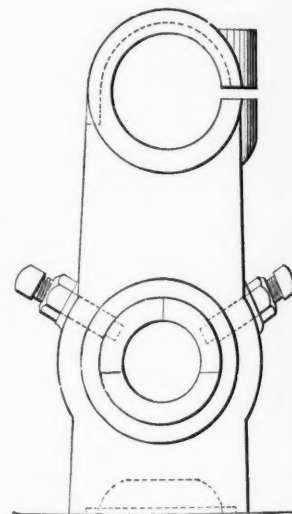


Fig. 2. Details of Spindle Boxes.

ABSTRACTS OF PAPERS

PRESENTED AT THE CINCINNATI MEETING OF THE
A. S. M. E.

Because of its timeliness, perhaps the "star paper" of the session is that by Mr. Arthur Herschmann upon the automobile wagon for heavy duty. Mr. Herschmann is the mechanical engineer for the Adams Express Company, New York, and has been on an extended trip through Europe studying the automobile problem for his company. The result is the steam wagon for heavy duty that he has designed and to which much of the paper is devoted. As the paper will be of interest to the majority of our readers, copious extracts are made from it in what follows.

THE AUTOMOBILE WAGON FOR HEAVY DUTY.

Taking up the different propelling agencies which have been experimented with so far, we find that almost every known motive power has been tried. Steam was employed as early as 1820, and such wagons were built by the world-renowned Ericsson and Tangyes in England, and even James Watt is said to have constructed a steam carriage.

Naturally, in this country, leading the world in electrical subjects, expectations were greatest with electric vehicles. The

the construction of light storage tanks to render this power available for trucks, granting that other disadvantages inherent to the use of compressed air can be practically overcome. Weight for weight, stored electricity lends itself more readily to the propulsion of wagons, since it will, as it were, "keep pressure" until it becomes well nigh exhausted, while the air pressure falls gradually as the air is drawn from the storage tanks. The tank weight per cubic foot of air is about 85 pounds; the air itself weighs 11 pounds, and at 2,000 pounds per square inch, represents 0.27 horse-power hours. To heat the air, considerable weight has to be carried.

A great deal of experience has been gained with oil-motor wagons, though chiefly in the line of light pressure vehicles; and France, in which country there are many thousands of these vehicles plying, has led the world in their exploitation.

As regards freight vehicles, however, no important results have been obtained with the use of explosive motors. A motor wagon, on account of its great weight and peculiarity of operation, must have an abundant supply of power; so great, in fact, as to puzzle the uninitiated observer. We find that a load which can be easily negotiated by one horse, calls for a power equipment equal to about 14 horse-power on the part of a motor wagon. While we commonly understand that 1 horse-power

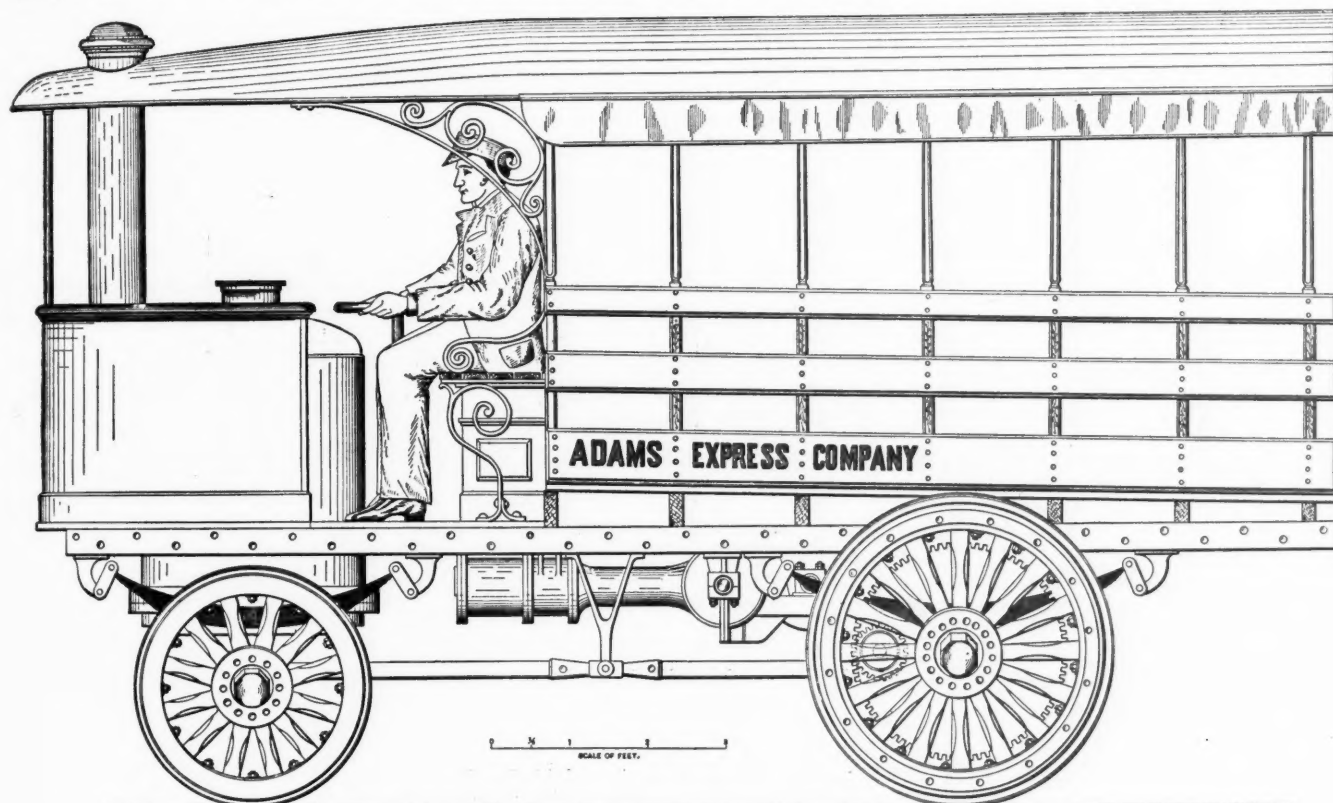


Fig. 1. Side Elevation of Automobile Designed for Heavy Duty.

electric equipment renders a vehicle clean and easy to operate. These vehicles can be made to answer the requirements of running on smooth city roads. The suitable commutation of battery cells provided in these vehicles, effected through interconnection of contacts on the "controller" affords, together with the series and multiple arrangement of the motor, some flexibility in the power and speed conditions of the machine. There are, however, inherent disadvantages to the use of batteries, which grow prohibitive in a motor wagon intended to carry heavy weights over a long distance. It is common experience that on rough roads the punishment is more than the batteries can stand, and where we have a case of heavy loads to be carried, necessitating the use of steel tires, we can well say that at this phase of the evolution the battery makes the electric truck an impossibility. The "maintenance" of batteries, apart from the actual cost of charging, is seldom spoken of, though it is perhaps the most serious item.

Next to the electric wagon we saw the auto-truck, or, better still, heard about it. It was stated that compressed air trucks would soon be operated in considerable numbers. Now, while it cannot be denied that compressed air would make an ideal motive power, we have still to look for a complete revolution in

equals 33,000 foot pounds per minute, we should consider how great the work of a horse can be for a short while on the race track, or when he becomes infuriated, and with "blind staggers" dashes into destruction. A horse, when required to pull a heavy load out of a difficult position, will not only jerk and lift the shaft so as to bring the wheels out of a rut and get them on a level, but will momentarily exert power which has been, by means of a dynamometer, shown to be adequate to a performance of what we commonly call 14 horse-power. Some people, in fact, assert that the horse can for an instant by far exceed the latter figure, but we may be well contented to accept this as a basis of calculation for the supply of motive power. The same horse having pulled his wagon out of the difficult position, is able to modify the output of his energy, propelling the wagon at a good rate of speed as soon as he reaches better ground. The "speed-changing device," which should as nearly as possible emulate the peculiarity of the horse's muscular system, is still the greatest problem with designers of oil wagons. An oil engine to run a motor wagon cannot be well designed to vary in speed, at least not in a wide range, and be satisfactory in other respects. Its construction necessitates its running at a constant speed, whilst the speed requirements of the wagon wheels, to

which it is geared up, are ever changing. Clutch and shifting gear wheels are, therefore, essential parts of every oil-motor wagon, and their operation, on account of the impact of the moving masses, often gives rise to serious trouble. Non-reversible, an oil engine is by no means a flexible motor. It will not start under load, and when it is in running condition it is very dependent on an even influx of its explosive mixture, and is liable to come to a dead stop without warning when its capacity has been suddenly overtaken. Anybody who may have gotten stuck with a motor vehicle while ascending an incline will appreciate these remarks. In such a case it will occur to him that it is very difficult at the same time to release the brake and start the wagon "ahead" on slow speed. It need hardly be said that an oil vehicle is dependent on the weather, inasmuch as the action of the carburetor is influenced by the atmosphere. This latter idea leads to the subject of perfect or imperfect combustion and its attendant outward sign, which is an evil-smelling exhaust. The good behavior of large oil engines on heavy trucks after an extended period of running has not yet been satisfactorily proven, and the deterioration due to the pounding on the frame is a serious drawback. The general use and handling of large quantities of gasoline at this stage of evolution of the oil engine is by no means free from risk of ex-

to be delivered only on the exact route covered by the wagon seeing that the daily carrying capacity of a horse is limited, while in the case of a large steam wagon this would be less important, since, as will be shown later, the percentage of operating expense due to the actual cost of propulsion proper is infinitely smaller than in the case of traction with animal power.

Construction.

Easy riding wagons have been constructed for many years, and boilers, steam connections, and engines do not give much trouble on rock bottom foundations, but when we attempt to locate engine and boiler on a wagon, which latter they have to drive without suffering from the shock of the locomotion on rough roads, new complications arise which are infinitely more important and troublesome than most people believe who have devoted themselves to the study of this subject. We find early attempts to effect this compromise in a steam vehicle built by the Ericssons in England in 1830, who placed a vertical engine on the rear of their vehicle, and coupled it up with a long springy connecting-rod to the front wheels, which acted as drivers, thereby preventing excessive shock being transmitted from the wheels to the engine.

Wheels in themselves are far more important problems than is generally believed. My opinion is, that at the present day no

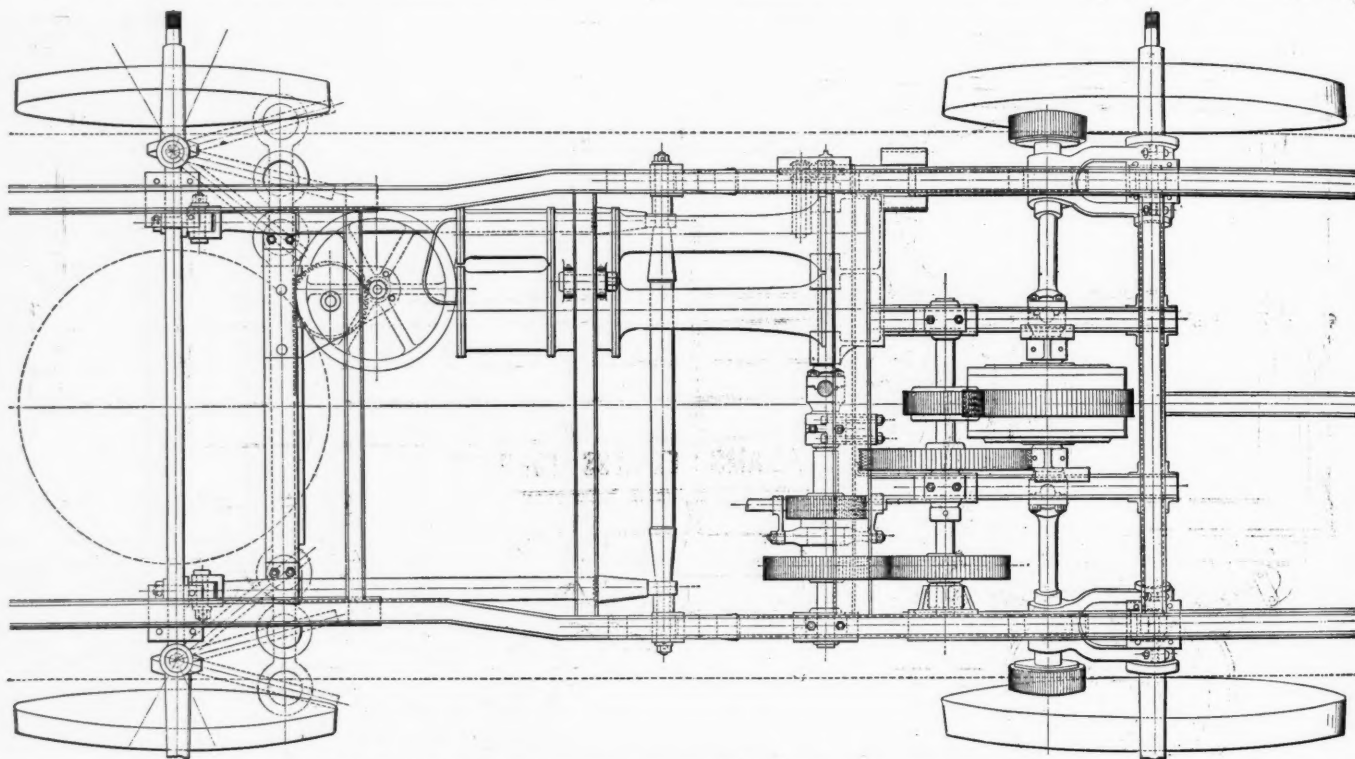


Fig. 2. Plan of Heavy Automobile showing Driving Gear and Steering Mechanism.

plosion, and there is some danger of affecting perishable goods and foodstuffs by the odor, which would naturally permeate them, particularly while standing at the express company's depot.

We have found the steam wagon superior to its competitors for the following reasons:

1. It has the greatest load and mileage capacity, or, in other words, radius of action.
2. Its operation is independent of charging stations, and supplies necessary for the operation of the wagon can be easily procured and taken aboard quickly.

The operating expenses in the case of an electric (or, in fact, of any power storage system) vehicle, grow to be prohibitive as soon as a certain ton mileage capacity is exceeded, tending to keep such an electric wagon small in size.

In the case of an oil wagon such economic restrictions to the size do not exist, and the objections to an oil wagon of large capacity are more by virtue of difficulties in operation.

With steam the case is altogether different. The tendency is here, to build a large wagon, since with a steam wagon the weight of the machinery to be carried does not grow even in an arithmetical ratio to the carrying capacity. One advantage found in the operation of a large steam wagon may not be apparent to the casual observer. In the case of the horse-drawn wagon one has to discriminate in loading it with goods which are

form of rubber tire will give satisfaction on a commercial wagon intended to carry a net load of, say, one ton or more. The rubber tire is not only expensive, but gives poor satisfaction under the combined action of great weight and speed. Attempts have been made to retain the desirable features of a rubber tire, protecting the latter with a tire shield of steel, dating back as far as the early 70's, but it would seem that such combinations are just as troublesome to maintain. Steel tires, if properly applied to stiff wooden wheels, have been proven to stand most severe work, and they afford the advantage of strengthening the wheels very considerably. It is my opinion, that well constructed springs of ample proportions, are, alone, the means to lessen the shock to which a wagon wheel is subjected. In the case of dished or, cored wheels, which I consider to be best adapted for heavy work, a steel tire is indispensable, since it binds the wheel together and prevents the spokes from being torn out when striking an outer obstruction. There is considerable divergence of opinion as to whether a comparatively narrow tire or a wide tire should be used, whether the wheels should be small or large, and whether the front or hind wheels should be driven or steered. While it is a fact, even in the case of motor-propelled vehicles, that the width of the tires should be smaller on hard roads and greater on soft roads (but not on sandy roads or in snow), I think that in the case of steam

wagons the total width of the tires in inches should be at least twice the number of gross tons carried when small wagons are concerned, say of a capacity of two tons of net load; this coefficient of two, to decrease, in the case of very heavy wagons, to one and even under.

The reason why small driving wheels seem to be exclusively used on motor wagons are mostly that it is difficult to design large wheels which will stand such severe strains as motor wagon wheels are subjected to. In this case the spokes of the wheel

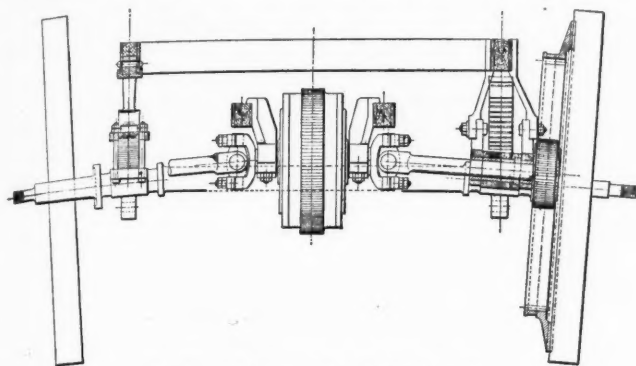


Fig. 3. End Elevation of Driving Gear.

not only support the load, as in a horse-drawn vehicle, but they are more or less affected by the action of the driving power, and, moreover, there is also a tendency to twist them. With the ideal wagon wheel the power should be applied directly where the wheel touches the ground. In reality we drive onto a spur wheel, or chain wheel, concentric with the wheel, but, of course, of a smaller diameter, and such an arrangement makes it desirable that the wheel should also be small. Another reason making small wheels desirable lies in the requirements of the wagon, and the working of a high speed motor. In other respects it seems to me that a large driving wheel, say of 4-foot diameter, will answer much better than a 3-foot wheel, such as has been almost exclusively applied to steam wagons. I consider that not only will a 4-foot allow of a more powerful starting torque, but it will also save the driving gear, seeing that it does not sink in as deep as a small wheel when it passes over a depression in the road.

The argument presented by advocates of the "front driving" system is, that the wagon will steer a straighter course when the wheel strikes an obstruction, for the reason that the front wheels, in striking, tend to run over the obstruction, instead of being forced aside. I have seen such wagons steered behind and in front, and my opinion is, that any advantage of front driving is more than outbalanced by the disadvantages introduced in connection with awkward location of the machinery. One of the early steam wagons was driven by all four wheels, and if such driving could be practically effected, I think it would prove an excellent feature of a wagon. There are, roughly speaking, two steering systems used—steering with a fifth wheel, and, secondly, steering with pivoted axle ends. It would seem that the fifth wheel steering arrangement is more adapted for heavy work, leaving the wagon axle unbroken. In reality, this system cannot be as satisfactorily applied as steering with pivoted axle ends. To effect the steering of heavy wagons, spur gearing of suitable purchase has to be used, or a worm and worm wheel device. The latter seems to answer in one of the best designed wagons, but I do not consider it as desirable as steering by means of spur gearing, since it locks the gear, and besides, causes a severer strain on the wagon in case the front wheels strike an obstruction. In rounding a curve, the inner wheels necessarily describe a smaller circle than the outer wheels. To make this practicable, the steering device has to be correctly designed, and the two driving wheels have either to be driven by independent motors, or have to be linked together by means of a compensating gear. With a steam wagon it is not necessary to use any kind of a clutch while running, seeing that the steam engine is a very flexible prime mover. Nevertheless, I think that a speed reduction gear, which can be best provided by means of two sets of spur wheels of varying diameter, one set stationary, the other movable axially on a square shaft, forms a desirable adjunct to the mechanism, to be shifted when the wagon is at rest, so as to increase its traction power, and enable

it to negotiate any special hill, or extricate the wagon from a bad position.

The next question we have to consider is the boiler and engine. Among the steam wagons built so far, one can notice a great variety of boiler designs. The desiderata of a suitable boiler for a motor wagon are that it should be of the greatest safety, of small proportion, quick steaming and economic. In addition, it should be of the simplest possible construction, and free from joints likely to work loose by jarring on the road. Pipe boilers, while perhaps a little safer than shell boilers, carrying little water, are, for the same reason, undesirable for the varying demands made of a wagon boiler. There are other objections to small calibre pipes; they are necessarily exposed to intense heat and liable to burn, and without a large dry tank they will make wet steam. A shell boiler, on the other hand, can be made of ample proportions, and, if well constructed, and watched during its use, should give no apprehensions as to its safety. The water level can be more evenly maintained, and this is a point of some importance. I consider a superheating device an all-round advantage, provided it is correctly applied to the boiler.

The firing of a wagon boiler, can be most easily effected by means of an oil burner, and with a steam governed burner the firing will automatically respond to the requirements. However, in addition to the inherent disadvantages of using oil, it is difficult to maintain the burner in good trim during all kinds of weather, and at this stage of perfection oil burners will "roar" and occasionally give trouble and make smoke. For the latter reasons coal and coke are preferable, being besides cheaper in use. Solid fuel can be conveniently stowed away, around the boiler, which latter is generally fixed in front of the wagon. In using a shell boiler it is found convenient to fire through the boiler top, a system originally introduced into steam-wagon practice with the De Dion boiler.

The difficulties with which one has to contend in the use of steam wagons are, that they will occasionally show a little steam, and during a sharp frost it will be found difficult to prevent a pipe from being frozen up. "Blowing-off" will be found annoying, but this nuisance is largely caused by neglect of the driver and is suppressible.

The engine so far used is in almost every case a compound. If of vertical design it can be located under the driver's seat; while if of a horizontal type it can be suspended from the body. In all cases a light, and well designed, quick revolution engine will answer the purpose if it be fitted with a reversing gear, and means to admit high pressure steam to the low pressure cylinder. The cylinder ratio should be larger than with stationary practice, seeing that the pressure used is higher, and that a large, low pressure cylinder means a powerful starting moment under live steam, and especial care has to be taken to connect the engine to the frame in an efficient manner. A fly-wheel is sometimes fitted, and then used as a brake wheel, but I deem it unnecessary.

ELECTRIC TRANSMISSION.

A timely paper by Prof. William S. Aldrich deals with the systems and efficiency of electric transmission in factories and mills. After comparing briefly the advantages and disadvantages of electric, steam, compressed air and hydraulic transmission, he compared, in a general way, the efficiency of electrical transmission and of the mechanical transmission that the newer system is fast superseding. It is well known that almost all examples of mechanical friction, as in steam engines, shafting, etc., show that power lost in friction is practically constant with all ordinary ranges of loads, provided the speed is constant. He assumes the case of a 275 horse-power engine with a mechanical efficiency of about 90%. From data that he has secured, he estimates that this engine in driving heavy machinery through belts and shafting would deliver 45% of its power for useful work at full load; at three-quarters load there would be only 28% available for work; and at half load there would be nothing left for useful work, all power being consumed in overcoming the combined friction of the engine and the transmission machinery. Other striking examples in mechanical transmission are given in diagram form, showing the heavy losses that have been found to exist with various classes of machinery.

In the electric transmission of power for similar manufacturing purposes, the distances are so short that there is really no necessity for considering any of the so-called line losses which figure

so prominently in long-distance electric transmission. The transformation of energy in the electric system from steam power into electric, thence to mechanical power, is accompanied with inherent losses, which are shown in Figs. 4 and 5. In Fig. 4 it will be noted that electric motors have the characteristic feature of high maintained efficiencies at part load.

Three cases of electric transmission are shown in Fig. 4 as follows: Two 100 horse-power motors, four 50 horse-power motors and twenty 10 horse-power motors. The steam engine generating plant required in each case, at normal load rating, will be of 265 indicated horse-power, 275 indicated horse-power and 315 indicated horse-power, respectively. Some interesting features of the electric system are shown in this diagram. In what is probably an extreme case, with only small 10 horse-power motors in service, and these given quite a low rating, it will be seen that at full load (100 per cent.), 63 per cent. of the power applied at the engine is available for useful work; at three-quarters (75 per cent.) load, 62 per cent. of the power is available; at half load (50 per cent.), 51 per cent. of the power is available; while at somewhat less than one-quarter load all of the power applied is required to supply the losses in the engine, dynamo and motors.

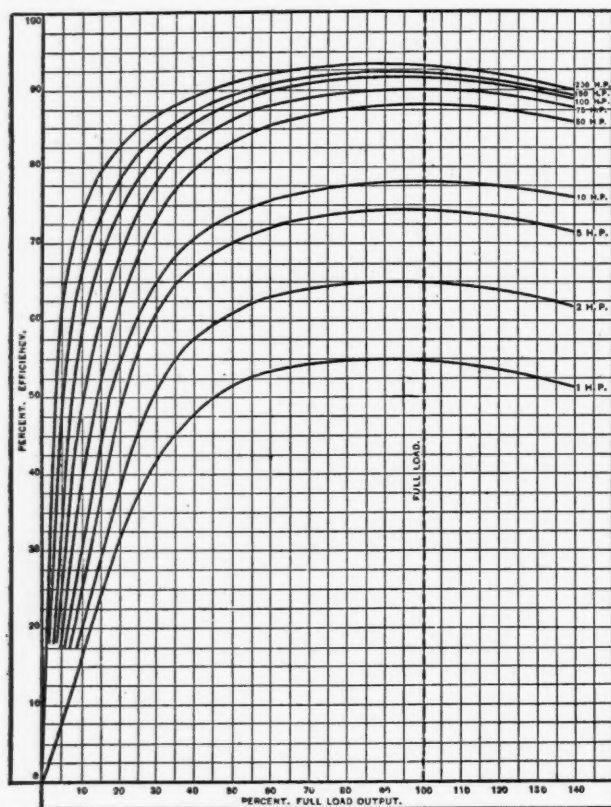


Fig. 4. Efficiency Curves of Electric Motors of the Same Type, but of Different Sizes, Ranging from 1 to 200 H. P.

The best performance of the mechanical system of transmission by shafting and belts is at full load. The best performance of the electric system may be maintained from 75 per cent. to 125 per cent. of the full load—from three-quarter load to 25 per cent. overload.

These differences become more vital when it is borne in mind that very few factories and mills are operated at full load all day. For machine shop practice, for instance, an average of about half time for the actual work would be rather liberal. In many shops several machine tools will not be worked much more than one-third of the time. The losses at these light loads are exceedingly expensive for the mechanical system of transmission, but scarcely require consideration in the electric system.

Systems of Electric Distribution.

In choosing a system of electric transmission for manufacturing work, it is not necessarily best to have that one system which will the most readily lend itself to all of the work to be performed, for light, heat and power service. A composite system may prove best suited, even in such short-distance transmission. That is, lighting service will, in general, be more satisfactory, and need not be more expensive, if supplied independently of the power service. Direct and alternating currents are equally

adapted for factory transmission, and by simple or multi-circuit systems of distribution; that is, by two, three, or four-wire systems, as the case may require. Preferably, all distribution should be direct; that is, without the use of storage batteries, rotary converters or transformers, except for certain lines of work in which it may be necessary to use one or the other of these indirect systems of distribution.

In the matter of voltages a wide range is possible: 110-volt two-wire and 220-volt three-wire systems for use of either direct or alternating currents for light and power; 440-volt two-phase alternating-current three or four-wire systems for both light and power; 550-volt direct-current two-wire system, or 550-volt alternating-current three-phase three-wire system, chiefly for power service, or the monocyclic system for both light and power. In general, it will not be necessary nor advisable to use over 550 volts, direct or alternating current. Shocks arising from accidental contact with wires carrying currents of this voltage are not necessarily dangerous. Experience has shown that workmen respect the distributing wires the higher the voltage. But it is not necessary to command such respect by raising it above 550 volts.

Electric Transmission by Direct Currents.

At the time that electricity was introduced into manufacturing establishments, the direct-current system was the only one available. For the peculiar and exacting service required in driving all kinds of machine tools and various workshop appliances, there were difficulties to be overcome with any system. It was necessary to secure satisfactory methods of producing a large starting turning moment, or torque, for varying the speeds as might be required under uniform or variable loads, and for reducing to a minimum the trouble arising from the use of a commutator.

These difficulties have been almost entirely overcome, and many refinements in design effected, so that the direct-current motor of to-day leaves little to be desired. Such objectionable features as still remain are inherent in the direct-current system used, and are found to lie chiefly in the kind of armature, commutator and brush devices required. These parts are most liable to derangement, require systematic attention for cleanliness and efficiency and renewals of brushes.

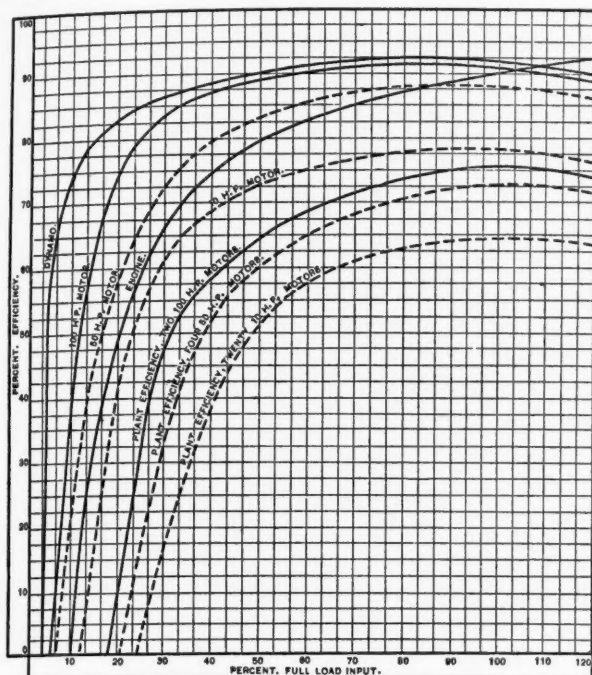
If a motor were sure of the daily care and inspection formerly bestowed upon shafting and belting, it would have made a much better record earlier in its history. Electric motors cannot usually be similarly inspected and attended to while at work as in the case of the older system of mechanical transmission. To have such work performed at any time requires a skilled attendant.

Electric Transmission by Alternating Currents—Induction Motors.

The alternating current system, with its induction motor service offered practically the only alternative to those engineers and manufacturers who did not care to be troubled with the petty annoyances and delays likely to occur at any time with the direct-current motor. The induction machine as it stands to-day is probably the most perfect motor yet developed from the standpoint of electric transmission in factories and mills. It may be started and operated from any point, at any time, at practically any load and speed within its predetermined ranges. It may be used on 110, 220, 440 or 550-volt alternating current circuits of one, two or three phases. It does not require any direct current supply as the synchronous motor does for its field excitation. It does not require any brushes, commutator or collecting rings. Offsetting these advantages, however, are certain restrictions. The speed of an induction motor falls off slightly as the load is increased, this being known as the slip. The ability to start an induction motor from rest under a heavy load, as well as the possible speed changes during its operation, are obtained at some sacrifice of efficiency.

Induction motors, moreover, permit of higher lineal speeds than are possible with any other type, from 6,000 to 7,000 feet not being infrequent. By suitable arrangements of its field windings, this type of motor may have its speed altered in regular steps, so reducing it one-half, one-quarter, one-eighth, etc. This makes possible similar changes to gear-wheel combinations, which may therefore be eliminated to the extent that the induction motor is installed to effect such changes. In almost all cases of shop driving, the slip is not objectionable, any more than the increasing slip of the driving belt as the load is thrown on.

These motors will stand almost any amount of rough usage and heavy overloads, as they cannot be burned out. If excessively overloaded, the motor slows down and stops, starting up immediately as soon as the load is lightened. Ordinarily, machine tools and almost all classes of shop machinery are started at quite light loads, and the full load is thrown on when the work or the tool is up to the speed desired. For this class of work the induction motor seems specially fitted.



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1899.	1899.	1900.
July	16,650	December ... 18,500
August	17,150	1900. May
September ..	18,000	January
October	17,500	February ... 20,500
November ..	17,750	March
		25,000

THE PARIS EXPOSITION.

As is apparent from the photographs shown in the first section of this issue and as is usually the case with an ephemeral undertaking like the great Paris Exposition now in progress, there is much delay and confusion in getting the buildings and exhibits into shape. From the nature of a great international fair, the work of marshalling together and organizing the exhibits into presentable shape is one of great difficulty, requiring executive ability as well as experience in these peculiar undertakings. One prominent cause of difficulty, which is very much in evidence in this case, is that many of those who should have been the most prominent exhibitors have delayed their requisitions for space until such a late date that their requests could not be granted in full and they have consequently found themselves restricted to ridiculously small quarters, where none of their products could be advantageously placed.

The dilatoriness of the United States officials in asking for space is peculiarly unfortunate to American machinery builders, as the space in the Champ de Mars is so restricted that a supplementary exhibition has been arranged at Vincennes, which

is about four and one-half miles from the Champ de Mars. While our machinery exhibitors will here undoubtedly have ample space and opportunity to exhibit their machines to the best advantage, they are put in the somewhat undesirable position of side-show exhibitors and will not have the prestige of the Exposition proper. On the other hand, the American machinist and the foreign manufacturer who are interested in American machinery will certainly not neglect the opportunity to visit the Vincennes exhibit, where the latter will be introduced to American methods and to a shop built according to American ideas by American workmen. The erection of the main building for this exhibit in eight days and by only fourteen American workmen is in itself an object lesson showing the energy and promptness characterizing American mechanics.

An international exhibition like that of Paris or our own World's Fair of '93 is a great educator and the effects on trade are of the most significant character. The old saying that "seeing is believing" is well borne out by the results of practical working exhibits where the actual operations are carried on before the interested party. At the same time personal acquaintances are made which in themselves are a most valuable asset to the man who desires to succeed in the commercial race. Another valuable experience that American exhibitors will gain who give their personal attention to their exhibits, is a knowledge of Continental customs and usages. These, which appear so insignificant to our practical American manufacturers, are often of the most vital significance, and if neglected will eventually lead to their undoing. There can be no doubt that the enterprising American manufacturer who expects to do business in Continental countries, must educate himself to an understanding of the peculiar conditions to be met, and the opportunity presented by the Paris Exposition is one that the wide-awake man will avail himself of.

* * *

LATHE SPINDLES.

A purchaser of machine tools will sometimes insist upon "up to date" features that are quite commonly assumed to be essential to the best results, when, as a matter of fact, the exact reverse may be true when the class of work that is to be done is taken into consideration. A particular instance is in the specification often made that the hole through the spindle of a lathe shall be of large diameter, though in many cases the purchaser has only a vague idea of what will be done with the "hole of large diameter" when he gets it.

It is true that for special work it may be necessary to have a good sized hole through the spindle to successfully handle it, and there is occasionally a piece that it seems almost impossible to hold in the chuck and operate upon unless there is this feature. In small shops, where the lathe has to do work that ordinarily would be done in the screw machine, and when lathes are equipped with a turret slide so that they may be used either as a lathe or a screw machine and work up stock from the bar, the large spindle hole is a necessity. Where lathes are used strictly for lathe work, however, and screw machines for screw machine work, the large hole may be a disadvantage, rather than otherwise.

Take the case of a 16-inch lathe, with a spindle, say, 2½ inches outside diameter. Suppose the lathe were ordinarily made with a one-inch hole through the spindle, with the idea that this size would enable a bar to be passed through the spindle and would answer the requirements for small screw machine work. This would give a spindle with reasonable stiffness for heavy work. If, instead of the one-inch hole, a 1½-inch hole were ordered, the spindle would lose about 12 per cent. in stiffness and the amount that the spindle would lose for each increase in diameter would be much greater in proportion than this increase. Thus, the increase from 1¼ inch to 1½ inch would weaken the spindle almost twice as much as the increase from one inch to 1¼ inch. It does not always pay to go to extremes, even with "up to date" features.

The same line of reasoning, however, will show that, given a spindle with a large hole through the center, the loss in strength can be compensated for by slightly increasing the outside diameter of the spindle. This increase can be considerably less than the increase in the diameter of the hole in order to secure the

same stiffness that the spindle would have with a small hole. If a large hole is insisted on by a customer, a spindle of generous outside diameter should also be specified. The tendency of American manufacturers is to furnish spindles that are so large as to be amply stiff, even when an unusually large hole is called for. It is more of an up-to-date feature to have a spindle thus designed, than to have a smaller spindle with a larger hole, and this is the point that should be looked out for.

* * *

(Continued from page 301.)

ABSTRACT FROM PAPERS.

each of the three steam cylinders. The steam cylinders are 29, 52 and 80 inches in diameter, respectively, the pump plungers are 33 inches in diameter, and each has a stroke of 60 inches. Connecting-rods from the cross-heads of each cylinder couple with cranks set at 120 degrees, and upon the crank shaft are two 20-foot flywheels.

All steam cylinders are jacketed on barrels and heads, and steam coils in the intermediate receivers, presenting a surface of 2,220 square feet, serve as reheaters.

The engine pumps against a pressure of 89 pounds, and has performed a duty of 147.5 million foot-pounds per million British thermal units. The steam consumption per indicated horsepower per hour is 11.38 pounds. A perfect engine working under the same pressure ranges would require 9.2 pounds. A comparison is made between this engine and the three others that, at the present time, stand in practically the same class as regards efficiency. The first of these is the E. P. Allis engine at Milwaukee, tested by Prof. R. C. Carpenter; its cylinders are 28, 48 and 74 x 60. The I. H. P. is 573.9; the steam, 11.68 pounds, and the duty, 137.7 million. The second one is the E. D. Leavitt engine at Chestnut Hill, Mass., tested by Prof. E. F. Miller. Its cylinders are 13.7, 24.37 and 39 x 72. The indicated horsepower is 575.7, the steam consumption 11.22 and the duty 144.5 millions. The Nordberg engine has cylinders 19.5, 29, 49.5 and 57.5 x 42, being a quadruple expansion engine. The horsepower is 712, or about 70 less than that of the Snow engine; the steam consumption is 12.26 with the heaters and 11.4 without; the duty is 162.9 and 147.5 millions.

The third test referred to was reported by E. H. Foster, of London, England, and shows the effect of superheated steam on the economy of a Worthington, duplex, direct-acting pumping engine. This engine is a triple-expansion engine of small size, the cylinders 12", 18" and 29" in diameter and the stroke 18". It was found that if steam were superheated about 125 degrees it would do 16% more work than when saturated. Taking into account the heat required to superheat this steam, it was found that, with the feed water passing through an exhaust heater, a given amount of fuel would produce from 11% to 12% more work. The engine was jacketed and tests were made both with and without the jackets. The effect of the jackets was to produce a saving of only 4% of the fuel or 3% of the feed water under the above-named conditions of steam superheated and feed water heated.

HEATING BY HOT WATER FROM A CENTRAL STATION.

In his paper upon heating by hot water from a central station, Mr. H. T. Yaryan, Toledo, Ohio, makes the somewhat startling statement that "if some great genius, like an Edison or a Tesla, were to announce to this society that electricity could be produced without cost, I imagine there would be a sensation; and yet the Toledo Heating and Lighting Company is doing this very thing, as the six months' business ending January 1st last shows, the record being 199 houses heated and 450 lighted."

Receipts from heating.....	\$9,900.88
Receipts from lighting.....	9,064.78
Expenses	9,764.54

The system that he refers to is a hot-water heating system used in conjunction with an electric lighting system, the exhaust steam from the engines driving the generators being utilized to heat the water for heating purposes. The hot water is circulated for a distance of $\frac{3}{4}$ mile from the central station and so efficient has the system been found, largely because the increase or decrease in the demands for both heating and lighting go side by side, that after an experience of five years it is pronounced a success.

The system, which is shown in Fig. 6, is so simple that but

few words are necessary to make it intelligible. The steam boilers, engines and dynamos are such as may be used in the ordinary electric light station. Heaters of the tubular type, through which the water passes from the pumps to the mains, receive the exhaust steam from the engines, heating the water to any desired temperature. When more exhaust is being produced than is required to heat the water, the excess is delivered to a water-storage tank to be used later when the output of electricity is small. The circulating system consists of two wrought-iron pipes, laid side by side in the ground, carefully protected by insulation, one pipe for the outflow of hot water impelled by the pumps, the other for the return water from the coils in the various houses heated, going back to the suction end of the pumps, to be forced again through the heaters, where the loss in temperature is restored.

The amount of coal consumed amounts to about 25 short tons per residence. These same buildings, if heated by their own furnaces, would average not more than 18 tons of hard coal each. The difference may be accounted for by the loss of heat in ground radiation, and largely by the fact that we heat the buildings more thoroughly and for a greater number of hours than they could or would do by private furnaces. The loss of heat through radiation in the mains is an important one, and probably amounts to 20 or 25 per cent. The water reaches the extreme end

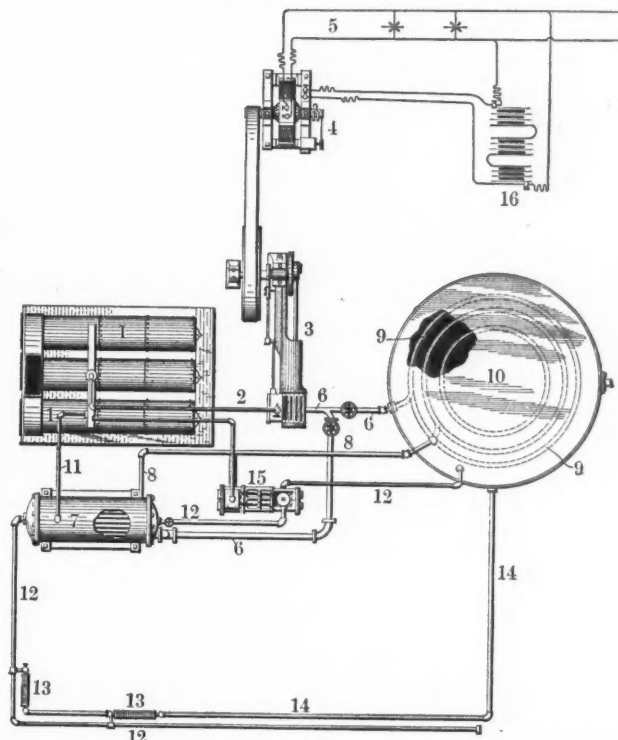


Fig. 6. 1. Boilers. 3. Engine. 4. Dynamo. 6. Exhaust Steam Pipes. 7. Heater. 9. Heating Coll. 10. Hot Water Storage. 15. Circulating Pump 16. Storage Battery.

of the lines, three-quarters of a mile from the station, in the coldest weather, with a loss of 12 degrees Fahr., which would be an average of 6 degrees to all of the houses. As the water returns to the station with a drop of 35 degrees, this would indicate about 17 per cent. loss in the ground. A pressure of 60 pounds is maintained on the feed line during cold weather and 40 pounds during moderate weather. The service pipes to the various houses are 1-inch pipe, and the return line throttled with a disc inside the building, the size of opening depending upon the quantity of radiation, but average $\frac{5}{8}$ of an inch. The houses are equipped with radiation sufficient to heat them to a temperature of 70 degrees Fahr., with water entering the house at 160 degrees Fahr., when the outside temperature is freezing. By raising or lowering the temperature of water one degree for each degree of variation in the outside temperature, we are able to maintain a constant temperature in the houses during all kinds of weather. There is no occasion for the consumer to regulate the flow of water during the entire winter, and with few exceptions our consumers open the supply valves in the fall and only close them in the spring. The extreme limits of temperature of the water is from 130 degrees in moderate weather to 212 degrees in the coldest.

THE USE OF REHEATERS.

Many of the leading steam engine builders are equipping their large multi-cylinder engines, which are intended for a high economy, with re-heating receivers placed between the engine cylinders. Dr. Robert H. Thurston has attempted to gather together, in a paper upon this subject, a statement of the advantages or disadvantages, of the re-heating receiver, but with only a fair degree of success. A number of leading builders express their opinion that the use of the re-heater improves the economy and that it is of sufficient value to warrant its use, although none of them appear to have any accurate data on which to base their opinions. There are but few tests available upon this subject, and those that are available are more or less contradictory. Those quoted by Dr. Thurston show a gain in economy of from 2 to 8 per cent. from the use of the re-heater, but in most instances the gain was so small that it is a question whether it would warrant the necessary expenditure for the equipment. Dr. Thurston points out that, both as a result of theory and of experiment, the re-heater, in order to be effective, must superheat the steam. If there is so much moisture in the steam when it enters the receiver that the re-heater fails to superheat the steam before it enters the next cylinder, he points out that it is best either to abandon the re-heater or to first eliminate the moisture by separating. The advantage of the re-heater comes simply from the fact that if it superheats the steam it will reduce the condensation in the low-pressure cylinder; if there be no superheating and the action of the re-heater is to re-evaporate the moisture in the steam, thus producing saturated steam, which easily condenses, the gain is so slight that it is overbalanced by the steam utilized in the re-heater. This is an interesting subject and one upon which more information is needed.

OTHER PAPERS.

Perhaps no more extended discussion has been accorded any paper than that which resulted from the one by Mr. M. T. Higgins, of Worcester, Mass., upon the education of machinists, foremen and mechanical engineers, at the December meeting. So much interest was awakened in this subject that it was decided to continue the discussion at the Cincinnati meeting. Mr. Higgins proposed his system of education whereby there should be a commercially successful shop where students should have practice during half the working hours, in five days of each week for a period of four years. They were to receive instruction in the public schools during a portion of the other half of the time and at the end of the four years it was calculated that those who showed natural ability could continue their course in the technical schools. Mr. Higgins' idea was that, by progressing in this way, the student could drop his course of training at any desired stage and find that what he had learned would be of practical value to him, and fit him in a measure for some position, the importance of which would depend largely upon the length of time that he had devoted to his studies. The paper upon this subject which Mr. Higgins presented for the Cincinnati meeting is largely in the nature of a reply to the previous discussion, and is not of a character that will bear summarizing.

Another subject that evoked so much interest that it was thought best to bring it before another session is Mr. Rockwood's paper on the "Value of a Horse-Power."

A subject that comes up for discussion periodically is a method for designing speed cones, so that the length of belt will remain constant for each pair of steps of the cones. Mr. James J. Guest, of Birmingham, England, has submitted a new formula for the design of such cones, which appears to reduce the problem to a comparatively simple form. It is a question, however, whether the requirements of practice justify so much attention to the mathematical treatment of this problem. When it is remembered that, in the majority of cases, these cones are placed several feet apart and are connected by a belt that will run efficiently when it is either stretched or tightened an amount that is several times greater than the greatest error of the graphical method, it would seem that in most cases the approximate method was sufficient. When greater accuracy is desired in special cases, it is not a serious matter to calculate a set of speed cones by trigonometrical methods.

An extended paper that will be of interest to those in any way connected with the gas engine industry is that by Prof. Wm. T. Magruder, Columbus, O., upon the gas engine hot tube as an ignition timing device. A great many indicator cards are shown

to illustrate the variable conditions upon which the time of ignition may take place. A study of these conditions was made with the belief that they must be fully understood before accurate data can be obtained upon gas engine performance.

N. O. Goldsmith, Cincinnati, O., presents a brief description of a water-softening plant in use at the Lorain Steel Co.'s blast furnaces. The available water supply contains a number of impurities, of which lime and magnesia are important elements, that produce a hard boiler scale. These are precipitated by means of caustic lime and soda ash, which are introduced in exact and known proportions. Intermittent settling tanks, in which there are devices for mixing, are used for the treatment. The precipitate is finally removed by filtering and frequent analyses are made to insure the correct quantities of chemicals.

At one of the junior meetings last winter Mr. B. C. Ball, New York City, gave a carefully prepared discussion on cylinder proportions for compound and triple expansion engines. This paper is highly technical, though not mathematical, and was presented at Cincinnati.

* * *

THE CONVERSION OF FORMULAS.—2.

ADDITIONAL ILLUSTRATIVE EXAMPLES.

J J C.

The two following examples of the conversion of formulas from one system of units to another are as difficult as will often be met with, but the methods used in each case will be understood by referring to the explanation and examples in the last number:

Problem 5.—Kutter's formula as originally stated is

$$v = \frac{23 + \frac{1}{n} + \frac{.00155}{s}}{1 + \left(23 + \frac{.00155}{s}\right) \frac{n}{\sqrt{r}}}} \sqrt{rs}$$

in which v = velocity in meters per second, r = hydraulic mean radius in meters, n = coefficient of roughness, and s = sine of angle of slope. Convert so that v and r will be in feet.

Solution.—The only variables entering into the formula are v and r ; hence,

$$\begin{aligned} \frac{[v \times 3.2809]}{3.2809} &= \frac{23 + \frac{1}{n} + \frac{.00155}{s}}{1 + \left(23 + \frac{.00155}{s}\right) \frac{n}{\sqrt{3.2809r}}} \sqrt{[r \times 3.2809] s} \quad (a) \\ \text{Or, } v_1 &= \frac{\left(23 + \frac{1}{n} + \frac{.00155}{3}\right) 3.2809}{\sqrt{3.2809} + \left(23 + \frac{.00155}{s}\right) \frac{n \times 3.2809}{\sqrt{r_1}}} \sqrt{r_1 s} = \\ &= \frac{23 + \frac{1}{n} + \frac{.00155}{s}}{\frac{1}{\sqrt{3.2809}} + \left(23 + \frac{.00155}{s}\right) \frac{n}{\sqrt{r_1}}} \sqrt{r_1 s} \end{aligned}$$

Whence, dropping subscripts,

$$v = \frac{23 + \frac{1}{n} + \frac{.00155}{s}}{.55208 + \left(23 + \frac{.00155}{s}\right) \frac{n}{\sqrt{r}}} \sqrt{rs}$$

Whoever first converted this formula obtained the very unwieldy expression,

$$v = \frac{41.66 + \frac{1.8113}{n} + \frac{.002807}{s}}{1 + \left(41.66 + \frac{.002807}{s}\right) \frac{n}{\sqrt{r}}} \sqrt{rs}$$

which is easily obtained from equation (a). This latter form is one generally used, and, so far as the writer is aware, he is the

first to state it in the form derived above. The new form is much to be preferred.

Problem 6.—Rankine's formula giving the relation between the pressure and temperature of saturated steam is, according to Wood

$$\text{Log } p = 8.28203 - \frac{2763.59}{T} - \frac{383683}{T^2}$$

in which p = pressure in pounds per square foot and T = absolute temperature Fahrenheit, the freezing point being taken as 492.66° absolute. Convert the formula so that p may be taken in pounds per square inch and the freezing point may be taken as 492° absolute.

Solution.—At 32° F. , the absolute temperature before converting will be 492.66° , and after converting, 492° ; hence, if we wish to change the freezing point from 492.66° to 492° , we must

multiply the reading at 32° F. before the change by $\frac{492}{492.66}$.

Then, for 32° , $T = 492.66$ in the formula, and we desire to change the formula so that T will be 492. Proceeding as before,

$$\log \left\{ \frac{\left[p \times \frac{1}{144} \right]}{\frac{1}{144}} \right\} =$$

$$8.28203 - \frac{2763.59}{\left[T \times \frac{492}{492.66} \right]} - \frac{383683}{\left[T^2 \times \left(\frac{492}{492.66} \right)^2 \right]}$$

$$\frac{492}{492.66} \qquad \left(\frac{492}{492.66} \right)^2$$

$$\text{or, } \log p_1 + \log 144 = 8.28203 - 2763.59 \times \frac{492}{492.66} - 383683 \times \left(\frac{492}{492.66} \right)^2$$

$$\qquad \qquad \qquad T \qquad \qquad \qquad T^2$$

Whence, dropping subscripts,

$$\log p = 6.12367 - \frac{2759.89}{T} - \frac{382656}{T^2}$$

This is an extremely unsatisfactory formula to convert, since it is only for a temperature of 32° F. that the formula will give exactly the same values for the pressures after conversion as before. The reason for this is readily found. Let T_1 represent the absolute temperature at 32° before conversion, T_1' the same after conversion, and t the temperature of the steam above 32°. Then,

$$\frac{I}{T} = \frac{I}{T_o + t} = \frac{I}{\left[T_o \times \frac{492}{492.66} \right] + t} = \frac{\frac{492}{492.66} I}{T_o + t \times \frac{492}{492.66}}$$

In other words, to obtain identical results, t must be multiplied by $\frac{492}{492.66}$ before adding to T_1^1 . This is never done in practice, the reading of the thermometer less 32° being always added. Since the original formula is purely empirical, the slight difference in the results may be neglected. If the original formula had been based on temperatures indicated by thermometers, instead of absolute temperatures, the conversion could have been made exactly.

A good scheme to follow in cross-sectioning tracings is described by a writer in the "Mechanic Arts Magazine," who says that he never sections the original drawing accurately but merely indicates the sectioning roughly. After the tracing is ready for inking, he places a piece of stiff paper with lines about 1-16" apart, under the tracing paper and traces the required sectioning. If the sectioning is to be fine, every line is traced; but if coarse, only alternate lines are traced, or every third line for very coarse work.

THE EVOLUTION OF ARCHIMEDES.—3.

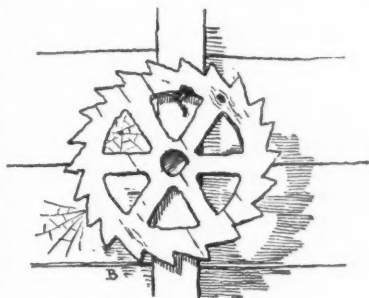
A TRUE BIOGRAPHY.

JUNIUS.

Now Ahaz was foreman of the woodshop at Bang & Ammer's and also did what pattern making there was to do. This latter was no small item in a country job shop and many of the patterns would have done credit to a modern pattern maker. For Ahaz never hurried and always took time enough to pare and gouge, and putty and polish, until the pattern was right.

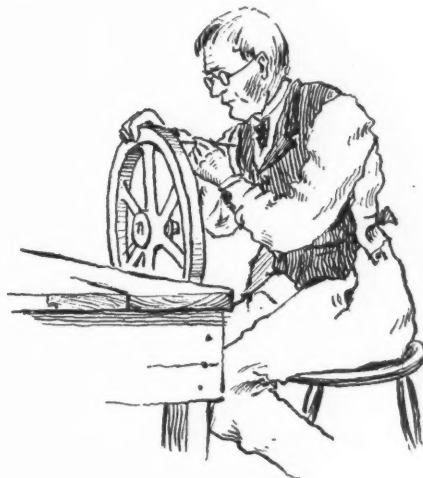
Sometimes a pattern came in from the country, made at some farmer's fireside, and these usually had to be made over to bring the shrinkage and the draft and the finish where they should be.

One pattern of a ratchet wheel about a foot in diameter hung on the wall over Ahaz's bench for many years, a curiosity. It had been sawed out of inch pine by some rural genius with a compass saw, and, in all good faith, it was brought to the shop, with the saw marks and the splinters fresh upon it, that it might be moulded and cast.



The Farmer's Pattern

Ahaz's strong point in his own estimation was gear teeth. After the blank pattern had been turned up and the pitch line scribed on the fresh wood, Ahaz got out his best dividers and put on his strongest spectacles. He spaced away patiently, changing his dividers from time to time and finally getting to the stage where he had to whet the points first on one side and then on the other, to make the divisions come out right. The next thing was to draw the tooth outlines and here was where Ahaz' superior knowledge came into play. He would carefully draw one tooth either on the wood or on paper, using circular arcs for the outlines. If he wanted a strong tooth he made it broad at the base; if a "light, free-runnin' tooth" was what seemed desirable, he shortened up his dividers and made the tooth slender, with beautiful reverse curves. Cycloids, involutes, describing circles and obliquity had no terrors for him; he had never heard of them, and "where ignorance is bliss, etc." After he had made his templates and transferred the curves to the pattern, he would some-



"Ahaz."

times modify them a little, turning his head from side to side and looking at them as an artist at his painting. When Archimedes asked him how he could tell, he said he knew by the looks when a tooth would run easy. And then he observed wisely: "If you don't get her just right, she will soon wear into shape." (We all know now that this is not so; nothing ever wears into shape, but everything wears out of shape, gear teeth, roads, nerves or religion; such is life.) It was this problem of gear teeth that first set Archimedes to thinking. He was bright enough to see that Ahaz' reasoning was at fault and that a gear tooth must be right or wrong, irrespective of the condition of Ahaz' eyesight or liver. Writing to a very good friend of his in Boston for help and in-

formation, Archimedes finally secured a book on drawing and some instruments. Then began the struggle with arcs and tangents, cycloids and involutes, when the fingers, stiff from the use of hammer and chisel, refused to curl around the drawing pen, and tired nature rebelled at the midnight oil racket. Archimedes sometimes went to sleep over the drawing board and sometimes got discouraged, but on the whole he enjoyed it and he persevered until he had drawn everything in the book (Cassell's Mechanical Drawing, I believe it was). I am afraid, however, that teeth constructed by methods there learned would not have run much more smoothly than those generated by Ahaz' critical instinct.

The upshot of it all was that our subject became dissatisfied with his country environment and emigrated to a city shop, in a neighboring state.

His new employers formed not a firm, but a corporation, which we will call the Merry Machine Co., and Archimedes found himself but one of the smaller units in a medley of several hundred Americans, English, Irish and Germans. The shop itself was a large brick building of several stories, numerous ells and wings, and an all-pervading odor of rancid oil and soda-water. There were rooms and rooms and rooms, until our country man felt as if he would need to spot a trail to prevent getting lost. The reader will perhaps remember that one of Conan Doyle's heroes used to mark the door-posts in Paris with his hatchet, just as he had been wont to mark the trees in his own Canadian forest.

Archimedes found no margins now on his time card; he must be in his place with his overalls on when the whistle blew, and he must not leave it until the whistle blew again. "James," his foreman, was a pleasant man and kind to the country youth, but he had sharp eyes and a cold, stern voice for the transgressor.



"Pat."

The Merry Machine Co. had a tool room on each floor, one vertically above another, in a fire-proof tower, with tin-lined doors. This may not seem worth mentioning, but it was a great revelation to Archimedes. To be able to go to a room like this with everything in order and get what tool or mandrel he needed all ready for use, was something new in his experience. But to have to carry them back again and not keep favorite tools in his chest or his drawer, there was the rub. And then Pat, who had charge of the tool room on this floor, was inclined to be crusty and to think he knew much better than a green country lad, what tap or reamer was needed. The company built interchangeable work and had an elaborate system of gages, plugs and collars for standard sizes. Queerly enough, as they had originated their own system at a time when standard gages could not be bought, most of the sizes were arbitrary and did not represent inches and sixteenths. Once begun, the system had to be carried out, and it gave them a monopoly of their repairs.

Although Archimedes felt like a cat in a strange garret, he soon lighted on his feet. He was tried at first on simple jobs of turning and fitting, but a man who has learned to make fits in a country job shop, with stick and calipers, soon tumbles to the use of a plug gage, and one who has had to locate holes with a prick-punch and bore them with a flat drill, finds the twist drill and jig business a cinch. In short, James the foreman soon discovered that, as the new man was not dependent on jigs and gages for close work, he would be a good man to make those same jigs and gages. An apprenticeship in a country shop, where one has to do much with little and to invent the tools as he goes, gives a self-reliance and independence which the more favored craftsman often lacks. Archimedes felt much more at home in making a jig from the raw material than in using one. He enjoyed laying them out from the drawing with surface gage, square and scriber; marking the holes to be drilled with dividers and center punch; drilling carefully with a thin-pointed drill, correcting at the start with a chisel, until the lips of the drill just touched the circle of punch marks; and so on until the final testing of the jig on a casting satisfied the keen eyes of James. Archimedes did have some struggles with the twist drill at first, until he learned

to grind both lips the same, and he sometimes longed for his old, flat-footed friend.

All the planers were located in a room by themselves and formed a little kingdom at one side with "Jim" for its monarch. Why is one foreman always "James" and the other "Jim"? Jim was very proud of his room. He could take a bar of machinery steel, cut it up into pieces, and by a series of skilful operations, planing twenty or more pieces at a time, manufacture small machine parts at a surprisingly low cost. Jim had a great contempt for milling machines, and, indeed, at that time, the milling machine was only a lusty, growing child, just cutting its teeth, as you might say, and with a great appetite for oil. I am afraid that to-day that planer room could hardly hold its own with the milling machine. Archimedes had never seen a milling machine, and although he soon learned to use one, he never liked its growling, squeaking ways, its splintery chips and the smell of hot oil and soda water which always went with it.



"Jim."

As has already been said, there were all sorts of nationalities in the shop and it was quite a liberal education to hear them talk, a sort of lingual hash, so to speak, with various flavors. Archimedes did not try to understand the Germans, got along finely with the Irish and then ran up against a stump in the Yorkshire dialect. It seemed to him that the Englishman must have learned his vowels with his eyes shut, they were so badly mixed. One day a native of Yorkshire was up on a ladder, oiling and wiping the countershaft of his lathe, and, seeing Archimedes below, he called in stentorian tones: "Wull yer 'ond moy ther breesh?" Archimedes simply opened his mouth and stared. Again came the cry from above. This time another Englishman came to the rescue and handed his compatriot a brush, while Archimedes thoughtfully contemplated "English as she is spoke."

The line shafting in this shop was well loaded with pulleys and a perfect maze of belts, weaving in and out to the long lines of lathes, so that it was no easy matter to mend a belt or oil a shaft. One day a new hand noticed that the long belt from the counter of his lathe to the line shaft was slack and needed mending. Getting a shifter from the tool room, he ran the belt off the pulley, where it very promptly began to wind up. Seeing the danger, the man yelled to his mates and ran. Just in time, for in



Talking English.

an instant more the countershaft tore from its moorings with a crash, swung whirling through the air and finally landed atop of an engine lathe, making a nest for itself as it twisted and squirmed in its last struggles. Fortunately, no one was injured, but the accumulated time of a hundred idle men, during the fifteen minutes of shutdown worried the foreman for a week. Moral: Don't wind up a belt, lest it wind up your career.

As Archimedes was now working on special tools, he got well acquainted with John, the pattern maker, and they soon became great friends. Times were brisk now, lots of work and every one in a hurry. They found out in some way that Archimedes could draw a little and rightly conjectured that he would not object to adding to his income by drawing overtime. John made him a new drawing-board and he began to get up at four o'clock these spring mornings and put lines on paper. It required considerable will power to do this and his stomach rebelled, but twenty cents an hour meant a great deal just then. There is this to be said, that when a boy works ten hours a day in the shop, draws an hour every morning and studies mathematics in the evening, Satan, idle hands, etc., are not in the equation.

Times were so good and work so plenty that pattern makers became scarce and hard to get. The company conceived the bright idea of hiring in a couple of experienced cabinet makers, arguing that with John to show them how they would soon catch on. It was a unique experience. In one sense green hands would have done better, for the cabinet makers knew such a lot of things that were not so when applied to pattern making, as to completely discourage their teacher. They panelled everything to prevent warping, were very particular about sharp corners and right angles, and abhorred such a thing as draft. As to any conception of getting a pattern into the sand or out of it again, that was far from them. After throwing away several nicely made patterns and making over as many more, John had to give it up and discharge the experts.

* * *

GAS ENGINE DESIGN.—7.

E. W. ROBERTS.

For opening the valves of a four cycle engine in which the operation is performed by means of a cam driven so that it makes one revolution to two of the engine crank shaft, the cam itself, or rather the shape of the cam, is perhaps as important a matter as anything about the design of the entire valve mechanism. The first requisite of a cam is that it shall open the valve which it is designed to operate at the proper point in the stroke and that it shall perform this operation with the least possible delay. In other words, it is desirable, as in the steam engine, to open the valves and also to close them in the shortest possible time. If, however, the highest possible speed is given to the opening and the closing of the valves, the outcome is a mechanism that is very noisy and for this reason objectionable. An attempt to design the cam after theoretical ideas, so as to open the valve with a constantly accelerated motion and to close it with a gradually retarded motion or negative acceleration, will usually result in a noisy device. The cause of this noise is the fact that valve springs do not operate rapidly enough to follow the curve of the cam on closing the valve and that upon opening the valve the cam will strike the roller a blow.

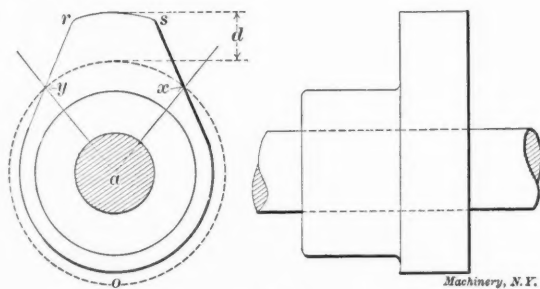
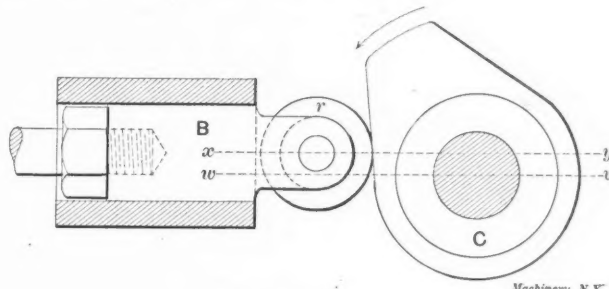


Fig. 29.

The cam shown in Fig. 29 is that usually adopted by those firms who have had long experience with the construction of gas engines, and this form is usually developed by the average builder after long experimenting. It is made up of two concentric curves and two straight lines which are tangent to the inner of the two curves. While this cam appears to give very good results in the operation of its mechanism it is also, because of its form, very simple to lay out and to construct. In laying out this cam, first draw the circle $o x y$ with a diameter equal to about $2\frac{3}{8}$ times the diameter of the cam shaft. On this curve lay out the angle $x a y$ corresponding to the time the valve should remain open. For the exhaust valve this angle should be such that the valve will open just as the piston has completed 90% of the expansion stroke and it should close just at the end of the exhaust stroke. Since

the cam shaft makes one-half revolution to one of the crank shaft, the cam shaft rotates through a quarter revolution or 90° while the piston is making one complete stroke. The opening of the exhaust should therefore be during $90^\circ + (90^\circ \times .10) = 99$ degrees or say 100 degrees for the entire opening of the valve. For the inlet valve the opening should be during one complete stroke of the piston and therefore while the cam is rotating through an angle of 90 degrees. The outer curve is constructed with a radius equal to that of the circle $o x y$ plus the lift of the valve or the distance d . The circle of the inner portion of the cam should next be described and be small enough to allow the cam roller to clear the cam when the valve is closed, in order that the spring may have full play to hold the valve firmly on its seat. The two straight lines ry and sx are



Machinery, N. Y.

Fig. 30.

then drawn tangent to the inner circle of the cam and so that they will pass through the points x and y . Rounding the corners at r and s completes the cam outline. In case the valve is operated by a lever the distance d must, of course, be made equal to the movement of that end of the lever which carries the roller, provided always that the valve is given the proper amount of lift.

The motion of the roller which bears upon the cam is transmitted to the valve stem in various ways. In Fig. 30 the most simple method is shown in which the roller r is placed in a fork on the block B , and the end of the valve stem is rigidly attached to the block as shown. In this case the center line of the valve stem and roller denoted in the figure xy should be on that side of the line wv —passing through the center of the cam shaft and parallel to xy —that the eccentric portion of the cam is located upon when the valve is being opened. Should it be desired that the engine will

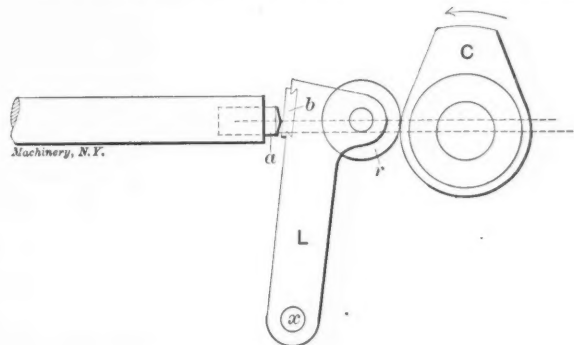


Fig. 31.

run in either direction the lines xy and wv should coincide. The objection to the latter arrangement is that it is liable to bind at the moment of opening the valve and thus cause undue friction.

In Fig. 31 the roller is carried by the lever L and the thrust of the cam is transmitted to the valve stem through the lever. The pieces a and b are hardened steel and are employed to prevent undue wear of the parts. The center of gravity of the lever L should always be placed at a sufficient distance to the right of the fulcrum x to cause the lever to fall toward the cam at all positions of the valve-stem. Fig. 32 shows an arrangement in which the fulcrum x is between the cam and the valve stem. This is a very good arrangement for transmitting the motion of the cam through a considerable distance and is much used by gas engine builders. It is open to the objection that the inertia of the moving parts may become so great with long levers and at high speeds as to perceptibly retard the opening of the valve. In order to prevent the noise due to the cam striking the roller, the arrangement shown in Fig. 33 has been employed and is the subject of a recent English patent. The lever is supplied with the movable tongue t pivoted at p and between the end of the lever

and the end of the tongue there is placed a spring *m* to take up the lost motion. With this device the roller is kept at all times bearing upon the face of the cam and the blow that results from the cam striking the roller is avoided. How successful this device has proven itself in practice, the writer is unable to state.

For determining the diameter of the cam shaft, the following formula represents good practice:

$$\begin{aligned} \text{Let } c &= \text{the diameter of the cam shaft in inches;} \\ D &= \text{the diameter of the cylinder in inches;} \\ \text{then } c &= .057 D + .625. \end{aligned} \quad (40)$$

Motion is transmitted to the cam shaft by reducing gears, of which the three types shown in Fig. 34 are those in general use.

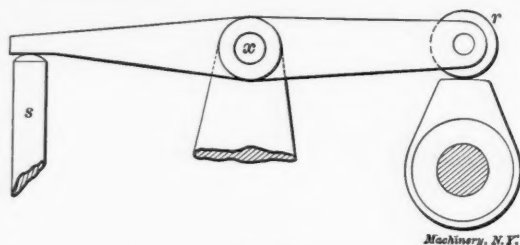


Fig. 32.

The spur gear shown at A is that employed when the crank shafts and the cam shaft S are parallel and close together. In a few engines the motion is transmitted by a train of gears when the shafts are parallel but some little distance apart. The bevel gears shown at B are employed when the shafts are at right angles to each other and when their axes lie in the same plane, so that a series of lines as *pq*, *xy*, etc., could be drawn through their axes and these lines would all lie in the same plane, or, in other words, would be laid upon the same perfectly flat surface

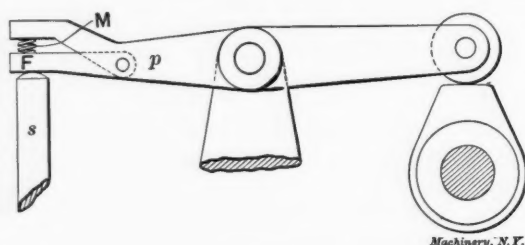


Fig. 33.

without changing their position. The skew, or helical gears shown at C are employed for shafts that do not have their axes lying in the same plane, and they may be used, if desired, at practically any angle to each other. In this case the gear upon the cam shaft may be, and usually is, made smaller than that upon the crank shaft. These gears are nothing more nor less than screws with multiple threads. Rules for laying out gears and for calculating the strength of gear teeth may be found in books devoted to that subject and they need not be treated in this series. It is sufficient to state that the strength of the teeth should be

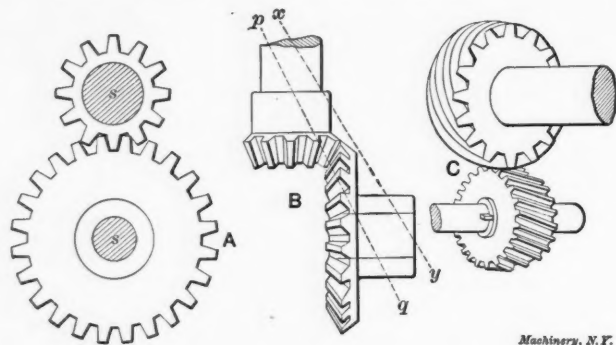


Fig. 34.

computed upon the basis of a pressure of at least 45 pounds upon the largest exposed surface of the exhaust valve, and ample allowance of strength made for sudden movement. The writer would advise the inexperienced designer to try at all times to keep the valve-operating devices as simple as possible. Do not have a separate cam shaft for each valve and for the igniter as well. One shaft is sufficient for every purpose, and for a multiple cylinder engine, wherein the cylinders are parallel and upon

one side of the crank shaft, it is nearly always feasible to operate every valve, pump, or other device upon the engine, from one shaft. Aim at simplicity and the fewest number of parts admissible for the effective working of the engine. More gas engines have been relegated to the scrap heap for neglect of this point than from any other cause. It is strange, but true, that the greatest offenders in this direction have been the designers of automobile engines. They have in many instances made themselves the laughing stock of the practical gas engine designer. There is probably not a purpose for which the gas engine is employed in which the simplicity of the motor is more to be desired.

Two general methods of controlling the speed of a gas engine are in use. In one the impulses of the engine are cut out from time to time according to the requirements of the service. This method of governing was probably the first in use and is known as the hit-and-miss method. In the other, the engine receives an impulse at every cycle, the speed being controlled by varying the strength of the impulse. For want of a better term the writer has called this the variable impulse method. Each of these general methods may be subdivided, the first into four and the second into three subheads.

Hit-and-Miss.

1. Holding the gas valve closed during the idle strokes, during which the piston draws into the cylinder a charge of pure air which is compressed and expanded.

2. Holding the exhaust valve either open or closed. When the exhaust valve is held open, the inlet valve is usually held closed by a catch which interferes with its opening, this method being nearly always used upon engines employing a suction inlet. When the exhaust valve is held closed the products of combustion are retained in the cylinder and are alternately expanded and contracted until the speed of the engine falls and the governor allows the exhaust valve to be opened again.

3. Cutting off the current from the igniter. This method is used with an engine having an automatic exhaust valve which opens only by the pressure of the exhaust operating an auxiliary valve as the gases escape through an auxiliary exhaust port. The charge is alternately compressed and expanded during the idle strokes.

4. Stopping the action of the cam shaft, and in this manner stopping the entire valve mechanism of the engine. The shaft is usually thrown out of gear with the governing clutch at such a time as will allow the exhaust valve to remain open during the idle strokes.

Variable Impulse.

5. Partial stoppage of the supply of gas. The amount of gas admitted to the cylinder is gradually reduced until the limit is reached beyond which the mixture would be too weak to ignite. At this point the supply of gas is entirely cut off and the engine is operating after method 1. There is also a limit at which the mixture becomes too rich to ignite, and this point represents the maximum power of the engine.

6. Throttling the charge. The proportions of the mixture remain constant at all times when this method is employed. Regulation is obtained by reducing the quantity of the mixture which enters the cylinder by choking the passage through which the charge must pass.

7. Varying the lead of the ignition. This method is, of course, suitable only to such engines as employ an electric igniter, although it might possibly be used with other forms of igniters in which a timing valve is employed. The ignition is said to have lead when the charge is fired before the compression stroke is completed. To distinguish it from late ignition it is quite often called positive lead. When the ignition is late, the lead of the spark is said to be negative. The later the spark, the less will be the mean effective pressure in the engine cylinder, so that the later the ignition, the slower the engine will run under a constant load.

The best economy of fuel is undoubtedly obtained by means of the hit-and-miss system of regulation. There is little choice between the several methods, each of which has its good and bad points, but they all operate about equally well. Of the variable impulse methods, No. 5 gives the best fuel economy. Method 7 gives the poorest results in fuel economy and is used only when economy is a consideration second to simplicity of operation and effectiveness. Throttling the charge gives the best results in regulation with a reasonable fuel economy.

Every type of governor in use upon a steam engine has been used at one time or other in connection with a gas engine, together with several types that have been designed expressly for use with a gas engine. As gas engine governors are most thoroughly described in the various books that have been written upon the subject, probably having received more than their just allowance of space, the writer will not weary the reader of these articles with repetitions of these descriptions, but will confine himself to giving a few general rules for the guidance of the designer.

Remember that all governors should be adjustable, so that the speed of the engine may be altered at will by changing the tension of the governor springs. If the adjustment can be made while the engine is running, it will, probably, be found a great convenience. The governor should be sufficiently powerful to operate the mechanism without waste of time. Always try to give the governor as little work to do as is practical, and in order that the governor shall be sensitive, it should operate the mechanism with the smallest possible amount of movement on the part of the governor weights or balls. Make the number of joints in the mechanism as few as possible, in order to avoid lost motion which would interfere with the sensitive action of the regulating device. Do not have the governor in a vertical engine catch a valve stem and hold it, as the valve will drop when the governor releases, and pounding will result.

* * *

STANDARD PUNCHES FOR IRON AND STEEL.

I. P. RICHARDS.

Uniformity of construction in all kinds of machinery is very desirable, both for the manufacturer and for those making repairs of the same; therefore any one who helps to bring about a correct standard makes labor easy and lightens the burdens of life.

With this end in view, I have tried to bear my humble part by introducing a standard for the common sizes of punches for punching iron and steel.

In 1869 while in charge of the screw department of the Whitin Machine Works, we were making square and hexagon nuts, and I found it was a great expense to keep the punches in order. We broke a good many of the small punches, and when broken the shanks were too short to be drawn out again, so that they were of no use except for the scrap heap. It required much labor and steel to keep the punches in working order, and naturally desiring to get along with as little work as possible, I conceived the idea of making the cutting part of the punch separate from the holding stock, forming a bevelled head on the punch and holding it to the stock by a screw coupling. After this arrangement I found it very convenient to keep punches on hand, and it was also a great saving of steel and labor.

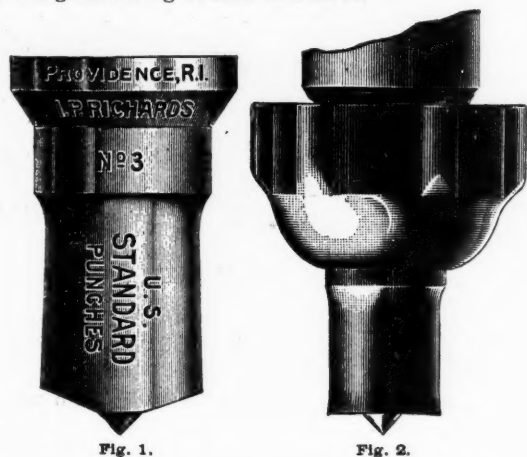


Fig. 1.

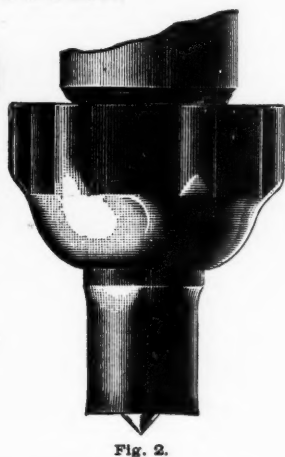


Fig. 2.

For cutting out nuts and washers, I made a hole entirely through the punch and inserted a movable center that could be driven out for grinding the face of the punch when dull, without drawing the temper, and also for using different sizes of centers in the same punch to suit the different sizes of holes. This was a valuable improvement in the manufacture of nuts and washers. The new style of punches worked so well that I determined to make a standard for the common sizes of nuts. In 1871 I removed to Providence, R. I., and, after making the necessary tools and standard gages, commenced to supply others with punches, which were found to be an improvement on the old system. A

few years ago I made a new standard expressly for riveted work, making the heads of the punches larger in diameter, thus giving them a more substantial bearing, with a new and stronger coupling, having special reference to the different sizes of rivets, bolts, etc. This is the U. S. Standard, and it has been adopted by nearly all who use punches in this country, for its economy and convenience.

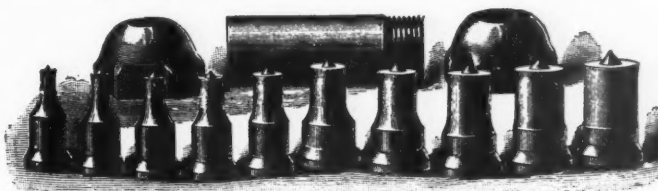


Fig. 3.

The U. S. standard includes all sizes from $\frac{1}{8}$ " to 4" diameter. There are twelve sizes of couplings, graduated to suit the different sizes of punches and numbered according to their capacity. Thus the No. 3 stock holds all sizes from $\frac{1}{4}$ " to 1" diameter.

For punches of large diameter I would recommend making the face of the punch so that it will give a shearing cut, as in Fig. 1. It will go through the metal with less power and with less strain on the work.

To do good work, punches and dies should be kept in good order. Some shops use punches as long as they will go through the metal, and sometimes long after they are badly worn. This causes a severe strain on the metal, and is not a safe way, especially on boiler work where all the strength of the plate is needed. With good sharp punches there is very little strain on the metal, and not so much difference between punching and drilling as some may think.

* * *

ENGINEERING DIFFICULTIES OF THE SOUTH AFRICAN WAR.

Capt. Zalinski, writing in "Harper's Weekly," says:

The layman cannot easily realize the vast amount of material as to food and ammunition demanded by an army in the field. A few facts and figures as to this may aid to make it more tangible. Each man requires, at a minimum, three pounds and a half of food per day. Each animal should have at least twenty pounds of food in countries where grazing is not abundant. If we take, for purposes of estimate, only fifteen pounds required to supply each animal, leaving five pounds to be gathered from the country, by grazing and otherwise, we assume a quantity that may be considered a minimum. An army of 150,000 men would require about 50,000 animals for transportation of artillery, camp equipment, ammunition, food, hospital and medical equipment. There should not be less than 30,000 cavalry. There should not be less than 10,000 animals available at all times to supply losses. This makes a total of 90,000 animals to be fed. With this as a basis, we see that the daily demands would be for the men 525,000 pounds, and for the horses 1,350,000 pounds, or an aggregate of 1,875,000 pounds. Assuming that, besides the food, an average of 100 tons of clothing, ammunition, and other supplies would be required daily, we have an aggregate of 936 tons. Six per cent. added for inevitable losses and contingencies would bring the daily aggregate up to 1,000 tons. Assuming, again, that a supply of at least 120 days should be provided for at the secondary base before operations commence, we have an accumulation necessary of 120,000 tons. With ten tons load per car, 12,000 carloads would be required. While this amount is accumulating, sufficient, in addition, to supply the army during the time of bringing this quantity to the front, would also have to be provided, so that no less than 15,000 carloads of ten tons each would be safe to assume as sufficing for the purpose. With railroads passing through the mountainous regions of South Africa, very heavy grades would have to be overcome, and high speed is impossible. An average rate, therefore, of only ten miles an hour would be counted upon, and they would require at least four days from Cape Town to Bloemfontein, allowing for unavoidable delays. The other roads could be traversed in from two to three days from sea to the places selected as secondary bases. It is not likely that more than 400 cars could be despatched daily on all the available roads, if sufficient numbers of cars and engines were at hand to commence the work. The traffic must be so managed as to permit the free return of empty cars. This would mean an initial supply of at least 3,000 cars, and no less than 100 engines.

LETTERS UPON PRACTICAL SUBJECTS.

NOVEL TURRET TOOL-HOLDER.

Editor MACHINERY:

Thinking it possible that the device represented by the enclosed blue-print might contain sufficiently novel features to merit your consideration, and prove of interest to the readers of MACHINERY, I beg to offer the following explanation of same. The device here shown is especially adapted to use on carriage turrets, for holding ordinary flat tools, and while it holds the tool G firmly in place, does away with the necessity of special tools to fit the slot. The bolt A which is tapped into the hardened bushing B binds the tool firmly on to the adjusting screws D D.

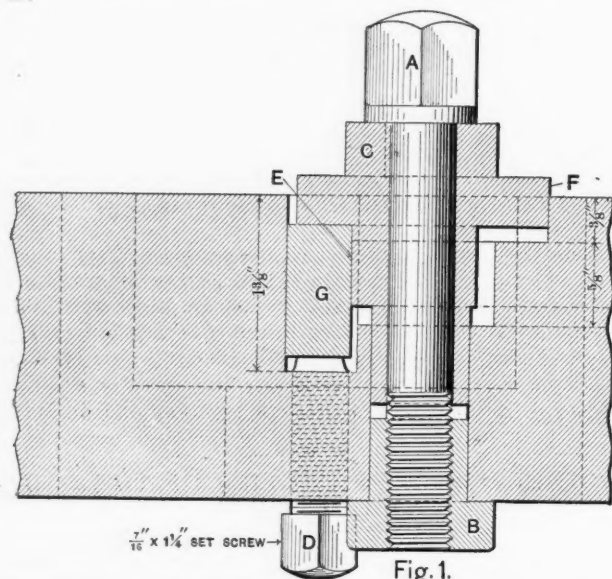


Fig. 1.

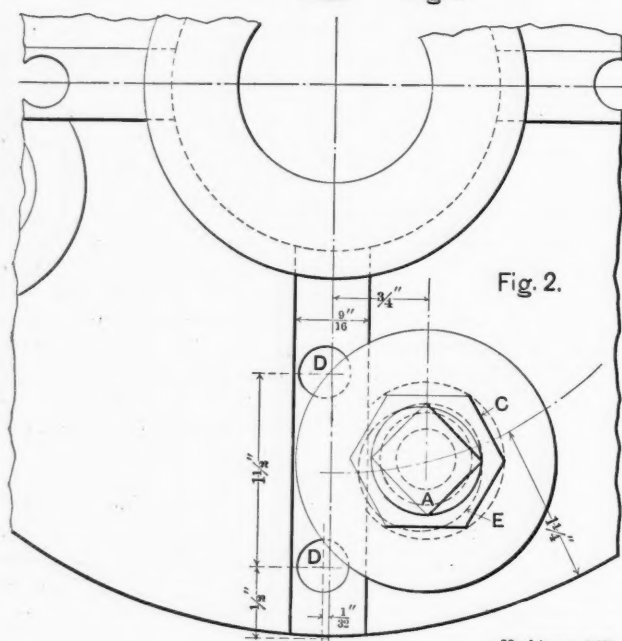


Fig. 2.

Machinery, N.Y.

Turret Tool-holder.

The hardened bushing C is milled at the top, for a hexagon wrench, and has an eccentric at the point E. This serves to bind the tool sideways. The turret is counterbored at F to receive the shoulder on C, thus preventing the bushing from tipping off sideways.

Dexter, Me.

W. L. FAY.

RADIATING SURFACE FOR STEAM HEATING.

Editor MACHINERY:

In a certain large building there are two rooms similar in design, but while it is an easy matter to heat one of them, it is impossible to heat the other enough to make it comfortable in very cold weather. On account of their resemblance, the results obtained in practice are of interest, because it shows it to be difficult

or impossible to lay down rules for designing steam-heating apparatus that will apply to all cases, as much must be left to the judgment of the designing engineer. Furthermore, it shows that even an expert may make a mistake along this line, for the building mentioned was designed by a prominent and reputable architect in the city where he is located, who has done much good work there. The rooms referred to are located on either side of a hall that is nearly in the center of the building, and both extend from said hall to the brick walls of the structure, in which are the usual windows. Both of them are bounded on one end by a large room extending across the whole building, and are separated from it and from the hall between them by partitions of matched sheathing, while a brick wall without windows forms the boundary on the other end of both. Beneath them is one large room, so that they are benefited alike by the heat from below, and the conditions above are precisely the same. They are heated by 1 1/4-inch pipes, located on their sides near the floor and are therefore on an equal footing in this respect. I shall refer to these rooms by numbers in order to make some interesting comparisons, calling the larger No. 1 and the smaller No. 2.

No. 1 is 61 feet long, 18 feet wide and 12 feet 4 inches high, containing 13,452 cubic feet of space. There are 8 windows, 3 feet 9 inches by 8 feet 6 inches, making 255 square feet of glass surface. The pipes in it contain 183.6 square feet of radiating surface. This shows that each square foot of radiating surface is expected to heat 73.75 cubic feet of space, that there are 1.39 square feet of glass for each square foot of radiating surface, and one square foot of glass for each 52.75 cubic feet of space. No. 2 is 42 feet long, 12 feet 9 inches wide and 12 feet 4 inches high, containing 6,604 cubic feet of space. There are 8 windows, 2 feet 9 inches by 6 feet 8 inches, making 146.4 square feet of glass surface. The pipes in it contain 152.76 square feet of radiating surface. This shows that each square foot of radiating surface is expected to heat 43.23 cubic feet of space, that there are .958 square feet of glass for each square foot of radiating surface, and one square foot of glass for each 45.11 cubic feet of space.

When these figures are taken into consideration it may be surprising to find that No. 1 is easily heated and No. 2 is often too cold to be occupied; for the conditions, so far as I have stated them, are nearly all in favor of No. 2, the only exception being the smaller amount of glass surface, compared with the cubical contents in No. 1, and even this difference is very small, so that steam fitters, after viewing the premises and having an opportunity to consider all of the conditions, claim that No. 2 is well equipped.

The only point in favor of No. 1 is that it gets the benefit of sunshine, while No. 2 does not. This appears to have been entirely ignored when the plant and building were designed, although it proved to be of much importance in actual service, so that after several years of trouble from lack of heat, 78 square feet of radiating surface has been added to No. 2, making it sufficient for the coldest weather in that locality.

W. H. WAKEMAN.

A LARGE PLANER.

Editor MACHINERY:

One of the largest, if not the largest, planers to be found in this country is located at the Boston Navy Yard in the department of steam engineering. The machine was designed by Seth Wilmarth and was built in the shops at the Navy Yard under his supervision in the year 1866. It will plane a surface 18 x 30 feet at one setting, and, with the cross rail at its highest point, will take work 13 feet high. The tool head is made in the form of an angle plate with relieving blocks and tool posts for tools to cut either parallel to the planer ways or at right angles to this direction. The latter cut is made by throwing out of operation the platen drive and driving the tool head back and forth upon the cross rail by means of the usual cross feed screw and a pair of independent clutch pulleys. By the aid of this arrangement, a tool head on the side frames, and slow feed motions for either the cross rail or platen—it is possible to plane top, sides and ends of a block at one setting. The cross rail carries also a boring rig for holes either vertical or at a small angle. The bed

is made up of nine separate castings, two sides and seven cross bars. Its total weight is about 110 tons. Its length is 40', height 5' 6", distance between centers of V rails 12'. The bearing surface of each V is 18" wide. The planer sides are of a somewhat fanciful pattern, such as was prevalent at the time that this machine was built. Each side consists of a top and base, in two pieces, and weighs about 20 tons. The cross connection at the top weighs about 10 tons. The platen is 12' long by 16' wide in two 6' sections. Its weight is 22 tons. It is driven by a 7" screw, a square double thread of 3" pitch working in a composition split nut 3' 6" long. The screw in turn is driven by spur gears from a shaft carrying two 4-foot clutch pulleys with 7" open and with crossed belts. The cross rail is 22' 8" long, 4' 9" deep and at the center about 4' thick and weighs 20 tons. It is supported by two 3" screws, with quick and slow drives for adjusting or feeding. The tool block is driven by a screw similar to the platen drive only it is 5" diameter and 2" pitch. The screw is driven by bevel gears from a vertical splined shaft to which either feed or cutting speeds can be given. The tool block has a bearing 5' 6" long on the cross rail and some idea of its size may be obtained when the relieving block alone weighs over 250 pounds. Although this machine is some 34 years old, there are many points about it which would do credit to a modern planer. It is at present in process of removal to new foundations, where it is expected it will in the future do as good work as it has in the past.

W. G. R.

A CURIOUS METHOD OF KEEPING TOOLS.

Editor MACHINERY:

The sight of the annexed sketches will surely make many people smile and wonder if they are not carried back to the ancient times of Egypt, many centuries ago, with her hieroglyphs, understood nowadays by only very few mortals. But such is not the case, they are simply an illustration of the way the Annamese toolkeeper of Marty & d'Abbadie's shop, in Haiphong-Tonkin, keeps track of the material entrusted to his care, and this, to the entire satisfaction of his employers.

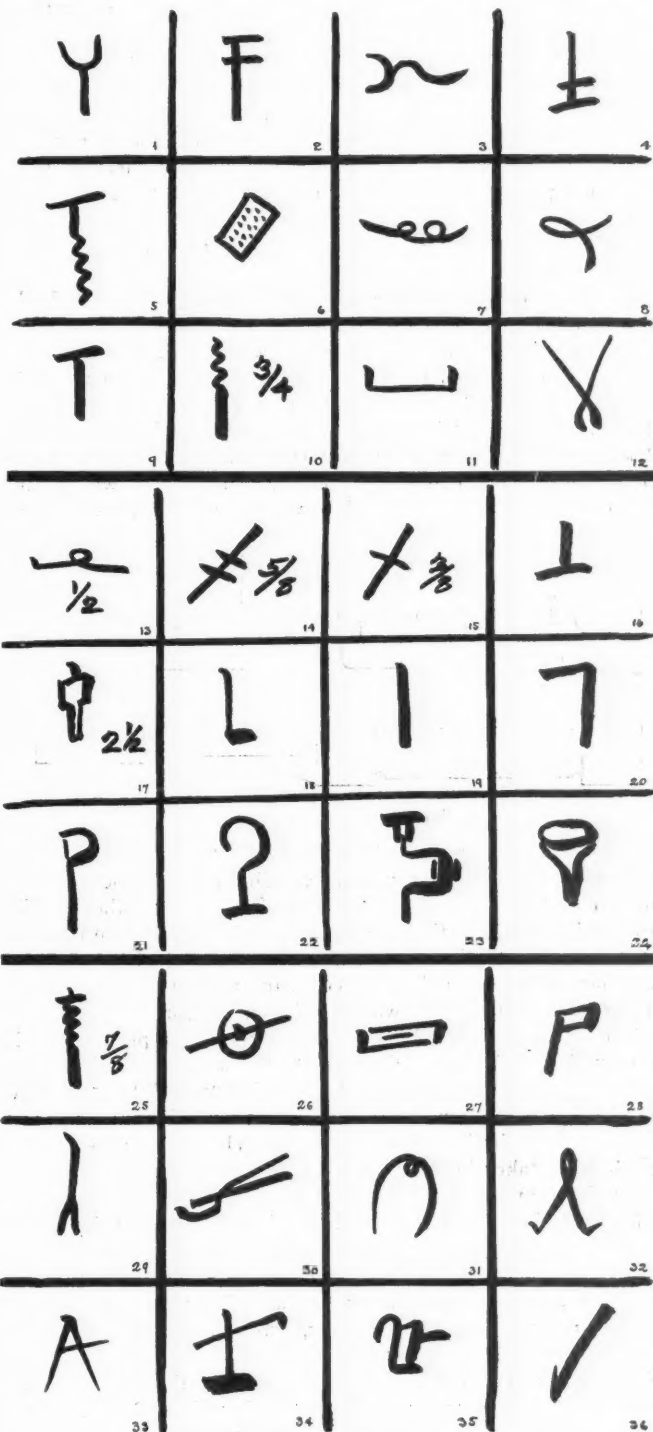
I will first describe the toolkeeping board. It is just an ordinary rectangular blackboard, 18" in height by 30" in length, divided in 50 spaces, each carrying a small nail on top to hook on the tags of workmen borrowing tools. Each man receives five of these tags, made of zinc and $\frac{3}{4}$ " square, stamped with his shop number, so that he may borrow several tools at a time. Once the tool delivered, the toolkeeper takes his chalk and scribbles a few dots and dashes, under the man's number, which are rubbed out when the tool has been brought back, and there you are. Some of the sketches are easily understood by everybody, such as those of brace, the pipe cutter or the surface gage, but the smartest American machinist would be at a loss to find out that No. 8 means an oil lamp and No. 15 the $\frac{3}{8}$ " reamer.

You must bear in mind, these are not Chinese or Annamese characters, but simply signs invented by our toolkeeper for his own convenience. Brass or zinc tags, as used in certain American shops, get lost through carelessness or theft of the helpers and of fitters coming into the room, whilst with a bit of chalk in hand he is never amiss.

I will now explain the meaning of these hieroglyphs: No. 1 represents an ordinary open end wrench; No. 2 is a monkey wrench with screw hand and No. 3 a nut wrench with screw jaw, called in England a shifting spanner; No. 4 shows a key wrench for screw propeller nuts; No. 5 stands for wood boring bit; No. 6 means the letters and figures; No. 7 is supposed to be a double-handed wrench for taps and reamers, while No. 8, which I mentioned before, represents an oil lamp, for all around use in the shop; No. 9 is a drill ratchet and No. 10 a Morse patent twist drill; a wood saw is meant by No. 11, while No. 12 shows plainly enough a pair of plyers; Nos. 13, 14 and 15 are, respectively, the $\frac{1}{4}$ " die, the $\frac{5}{8}$ " tap and the $\frac{3}{8}$ " reamer; No. 16 is the sledge hammer; No. 17 explains itself, it means a $2\frac{1}{2}$ " tube expander, and No. 18 a soldering iron. No use to say that No. 19 is a straight edge and No. 20, a "crooked edge," as the Chinese call it, otherwise a square; No. 21 represents a hack-saw, and No. 22, a pipe cutter. Every one understands No. 23, whilst No. 24 is a tin funnel. No. 25 is a $\frac{7}{8}$ " wood bit to fit brace No. 23. No. 26 shows you the small circular saw for cutting metal in a lathe. Three strokes of the brush have made a spirit level of No. 27.

No. 28 is a wood axe, No. 29 a crowbar and No. 30 a pair of pipe tongs. A set of 24" calipers and dividers is represented by Nos. 31, 32 and 33. It is plainly seen that No. 34 is a surface gage, but No. 35 needs a little attention to understand that a soldering lamp is meant by it. To conclude the list, No. 36 is a 24" cape chisel.

The reader will notice that these sketches, as simple as can be thought of, and made with a Chinese brush and ink, represent very well what they stand for, excepting three or four in the whole series. Some of them one would take for Chinese characters, but for the fact of there being no names in either the Chinese or the Annamese language to call most of these tools by, the former using English impressions and the latter French



Annamese Method of Checking Tools.

ones. For instance, a "monkey wrench" is called in Chinese "shiftspannah" and in Annamese "laclemolette," both words being "pidgin," one for "shifting spanner" the other for "La Clef a molette."

In fact, it is a kind of shorthand, which is certainly very curious and the invention of which is much to be admired in a man, who of his own idea, has made up such an ingenious system of toolkeeping in a country where, ten years ago, they had not the least idea of what a machine shop was, and would never

think there might be a difference between a tap and a screw or a monkey wrench and a hammer.

EDWARD C. CHODZKO.

Haiphong-Tonkin, Indo-China.

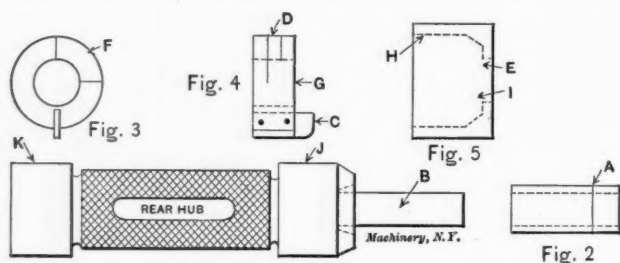
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GAGES FOR BICYCLE WORK.

Editor MACHINERY:

The art of manufacturing plugs and ring gages has become a science so I do not intend to deal with standard gages, but to speak of the gages used on a bicycle. It requires as much skill to make these as the standard gages—where they make a business of manufacturing that class of tools—simply because a bicycle shop as a rule, has not a tool room equipped for this sort of work. Take for example the plug and ring gage used to determine the size and thickness of a rear-hub cup. At the time these came into existence I was employed in a well-known bicycle shop and this job was given to me. The foreman handed me a pencil sketch and informed me that I was to make three plugs and rings from same. The readers of this letter will probably agree with me that this was pretty difficult work, considering there were no special tools for this class of work and the room was not of even temperature, as all places where this work is carried on should be.

The stock being already cut in pieces of a proper length, I was ready to commence the first operation. This consisted of centering and turning the plug shown in Fig. 1. The ends J and K were turned to 1.010 inches diameter, which allowed for grinding after being hardened, then the center part of the plug was turned .125 inch smaller and knurled. The small end B was turned .385 inch in diameter, which also left stock for grinding. The end J was then tapered in as shown by the dotted lines, and the small end B was relieved by a recess .005



Combination Gage for Bicycle Hubs.

inch smaller than finish size and extending .125 inch beyond the end of J, this being done to allow for grinding the end B without interfering with the end J. The end of J was then tapered on the outside to the same angle as the bottom of cup I, Fig. 5. These plugs were then placed in the milling machine and a spot on the knurled part was milled to allow for marking.

The bushing shown in Fig. 2 consisted of a piece of tool steel with a hole bored through it .370 inch in diameter. It was placed on an arbor and the outside turned to .510 inch diameter, the ends were faced to the proper length and this completed the bushing for hardening. The rings, Figs. 3 and 4 were then taken in hand. These were of tool steel with a hole through them .495 inch in diameter and were placed on an arbor and the periphery turned and knurled. The sides were then faced to the proper thickness and the rings were laid out for milling in the following manner: A center line was obtained and then a quarter line taken from that. The rings were placed on the milling machine and the quarter F, Fig. 3, milled out to the lines and through two-thirds the thickness of the ring. A side view of this is shown in Fig. 4. On the opposite side of the ring a slot was milled .0625 inch wide and as deep as was possible without risking breaking in the process of hardening. The blade C, Fig. 4, made of sheet steel the proper thickness, was then finished to allow for a slight drive in the slot. After placing the blades in the rings in their respective positions, the holes for the pins that hold the blade in place were drilled out and the blades numbered to correspond with the number on the ring. They were then heated and hardened.

Now came the grinding of the parts. The plug was taken first, the end K being ground to 1.000 inch diameter, the end J was ground to 1.002 inch and the end B to .377 inch diameter. A cast iron ring was then made, the hole being bored

1.000 inch in diameter and one side being split to allow the screw in the holder where it was to be used to adjust for the wear. The plugs were then placed in a speed lathe and, with flour of emery and benzine, a finished surface was lapped on each. At the same time they were reduced to their respective sizes, K to .998 inch and J to 1.000 inch in diameter. Another ring was then made with the hole .375 inch which, being used the same as the one just described, finished the end B and also reduced it to .375 inch, its required size. The object in making K .002 inch smaller than J was to serve as a limit in the size, to which the operator was allowed. Great care had to be exercised in measuring the plugs while lapping them as this operation caused them to heat and expand. To prevent any trouble the plugs were dipped in water every time they were measured. The bushing came next, a hole being first lapped to its desired size .374 inch, after which it was placed on an arbor, the outside circumference was ground to .502 inch in diameter, then placed in the speed lathe and lapped in the same manner as the plugs, the diameter of the bushing being .500 inch. The bushing was then taken and slightly heated over a flame of gas till it had expanded, then placed on the end of plug B and as it grew cold it contracted and fitted the plug tight. It was then covered with a thin coating of beeswax, then the plug was placed in a lathe and a sharp knife-shaped tool was placed in the tool-post and the line A, Fig. 2, was scratched around the bushing, great care being taken to have the line as fine as possible and to be sure that the tool had penetrated the beeswax to the surface of the plug. A strong solution of acids was then brought into use and the line was etched into the bushing, the beeswax being removed by slightly heating and wiping with waste. Now came the rings. The hole G, Fig. 4, was etched and the blade C, Fig. 4, was fitted and pinned into place.

Fig. 5 represents a rear hub cup when it is placed on the plug. The hole E should fit the bushing, Fig. 2. The hole H should fit the end of plug J which bottoms on surface I and the other end of the cup must be the same length as J. The cup now being in position on the plug, the ring was slipped on the bushing, the blade in the ring was gradually lapped on the end till the line on the bushing and that on the ring were exactly even, which showed the thickness of the bottom of the cup. The plugs and rings were now completed and turned over to the foreman.

The readers of this letter will readily see that this one gage did the work of four by giving the small hole, the size of the large hole, the depth inside and the thickness of the bottom. These plugs have been used successfully and are giving the best of satisfaction.

A. F. NOTROH.

* * *

BORING A LARGE CYLINDER.

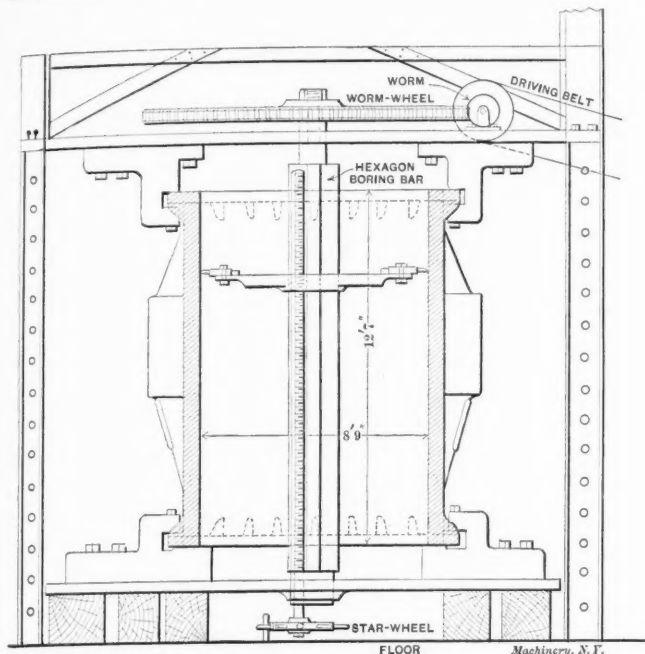
Editor MACHINERY:

To those who are interested in large and heavy work I think the accompanying sketch and explanation will be interesting.

The International Power Company have a cylinder in their shops being bored out to 105 inches diameter. It is an unusually large one at any rate for their shops and required special rigging and tools. The sketch shows the cylinder as it stands now. It will be observed that it is a vertical longitudinal section view, while the large worm gear and vertical shaft upon which the cutter feeds up and down are shown in full view.

To begin with, the cylinder is 105 inches bore and 12 feet 7 inches high. It is set up on a four-arm star and clamped to it by very large clamps with bolts acting as set-screws, the whole thing being set on solid oak beams, as shown. Eight more beams support the top braces and scaffolding and there is another big four-arm star which clamps to the flange at the bottom. In the center of these two stars are bearings for the vertical boring bar, which is hexagon up to within a short space of the bearings. On this bar are two arms standing opposite each other and in one piece, having a hexagonal hole which slides up and down the bar. The screw shown in the sketch is the feed screw which is set just below the face of the bar so as to make it eccentric with the axis of the bar. At the bottom this screw has a six-pointed star (a common wheel with six studs or fins in it) which strikes a small post driven in the floor with one of its pins. It will be readily seen that the feed screw, being off the center of the upright bar, will strike the post and as the bar is turning, it

will hold the feed star until the engaged pin can pass. The feed bar is thus fed one-sixth of the pitch of the feed screw for each revolution. The feed screw works in a nut in the boring arm and then at the top works in a box inside the end of the hexagon part. The boring arm has two pieces of steel forging bolted to the extreme ends; these pieces hold the two tools, which are common planer tools.



Method of Boring Large Cylinder.

The cutters make one revolution in two minutes and ten seconds and it takes from four and a half to five and a half days to make one cut (roughing) and about half the time for a finishing cut. I may say that the boring arm has to be raised after a cut by hand as it feeds down.

LOUIS A. SALMON.

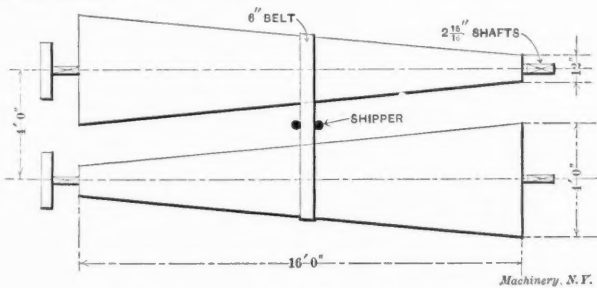
Providence, R. I.

* * *

VARIABLE SPEED DEVICE.

Editor MACHINERY:

During a conversation with an acquaintance, a few years ago, he spoke of a factory in which variable speed cones were used to a large extent and mentioned one in particular which is the largest known to the writer.



Variable Speed Cones of Large Dimensions.

The arrangement is shown in the accompanying sketch. The pulleys are made of properly beveled wood segments about $2\frac{1}{2}$ " thick and a little over 16 feet long, bolted to heads at the ends, and tied throughout the length by U-bolts which pass around the shaft and secure adjacent segments. The nuts were counter-sunk into the wood and wooden plugs driven in before the pulleys were turned. This style of pulley has been in use at this factory for several years and has given good service.

The device shown in accompanying sketch transmits about 15 H. P. maximum. The driving pulley runs at 150 R. P. M. and the driven pulley from 38 to 600 R. P. M.

WM. SANGSTER.

Jamaica Plain, Mass.

* * *

HACK-SAW GUIDES.

Editor MACHINERY:

Any one who has ever had anything to do with a power hack-saw knows how hard it is to get one to saw straight. The fixture here shown obviates this difficulty. By means of it I have seen

pieces of tool steel four inches in diameter sawn off, and it was done as well as in a lathe or cutting-off machine; and better than in either of these machines when run by a mechanic who grinds more clearance on one side of his tool than on another.

Fig. 1 shows the rig in position on the saw frame. There are two guides made in halves, as shown in the detail. The front guide is made adjustable and moves back and forth in the slot A to suit the work. The nut on the end of the bolt in Fig. 2 has a tongue that just fits the slot so as to keep it from turning when the guide is adjusted to the work and the bolt tightened. The back guide is like the front, with the exception that it has no nut on the bolt and is fastened to the saw by means of a hole tapped into the bed. The slot B is made to fit a new saw blade. Both

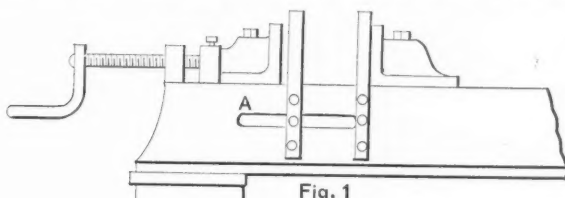


Fig. 1

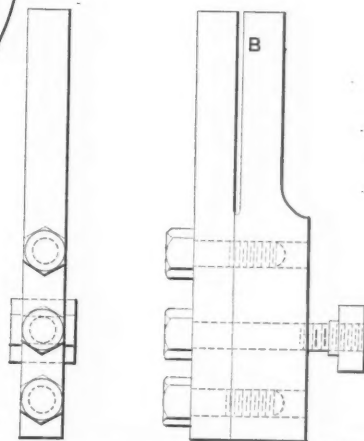


Fig. 2

An Aid to Accurate Sawing.

guides are hardened, and the edges of the slots rounded over to keep the teeth of the saw from catching. The back guide is placed a little ahead of the front edge of the vise jaw to allow the clamp for the saw blade to clear during its stroke. A strip is then put between the work and the jaw to bring the work out even with the front edge of the back guide.

WIN.

* * *

FISHING FOR WIRES IN ELECTRICAL WORK.

Editor MACHINERY:

I have had occasion lately to do considerable work in the way of concealed wiring for burglar alarm circuits, etc. Most of the readers of MACHINERY are doubtless familiar with the old-fashioned way of "fishing" for wires behind partitions, etc., by means of a wire rod with a hook formed on the end. Now this is a very slow and tedious process, and it is well named "fishing," for it takes quite a while before you succeed in getting a "bite." "Necessity being the mother of invention," I devised a tool by which the operation can be performed with no trouble whatever. For instance, suppose you wished to run a wire from an upstairs room to a window or door connection below; you simply bore a three-eighths inch hole at the top of the baseboard through the plastering (or wherever it is desired to drop the line) and drop



"Fish-hook" for Electric Wires.

your small chain attached to a string and then bore a three-eighths inch hole through the window or door casing where the connection is to be made. Now insert the tube with the "fingers" drawn back into the tube until the whole thing has been pushed through an inch or two. Then push on the wire which opens the fingers and push the tube further into the hole until you have passed the point where the string has been dropped; then pull

the wire and the string and chain will be drawn into the tube and the whole apparatus can then be withdrawn.

This device can be used in all places where it is necessary to do concealed wiring.

The accompanying sketch very clearly illustrates the device. The tube should be about $\frac{5}{16}$ inches outside diameter so as to easily enter a $\frac{3}{8}$ -inch hole. The wire fingers should be made of steel music wire and the wire rod for drawing the same into the tube can be made from galvanized wire, about No. 9 or 10.

CHAS. G. TAYLOR.

Burlingame, Kan.

* * *

MOVING AN OIL TANK.

Editor MACHINERY:

While at Dunkerque I ran across an oil tank 25 meters in diameter and 10 meters high (say 82 x 33 feet), which had been moved 50 meters laterally and at the same time rotated 180° on its axis so as to bring the outlet on the west instead of the east side (or as the engineer in charge stated it, "the discharge had to be 'oriented' west"). The tank held 4,000 tons of petroleum when full; its weight empty was 130 tons. Its thickness was from 6 to 12 millimeters = say, 0.27 to 0.53 inch. Its bottom was flat, and top rounded slightly. It rested on a beton bed 0.80 meter = 32 inches thick.

The first thing to do was to make the new beton bed in which it was to rest; then build a mortared masonry wall 0.50 meter = 20" high above the level of the old and the new beton bed, and to ram and puddle the earth well in the space over which the tank would have to be moved laterally and turned, because the tank was not to be moved on rollers, but floated to its new position and turned while floating. The 130 tons weight (empty) on a base of 49 square meters gave a draft, for the vessel into which it was temporarily transformed, of about 0.27 meter = say 10.8 inches. So a depth of water of 40 to 45 cm. = 16 to 18 inches over the cement bed would suffice to tow the craft and turn it.

I have already mentioned that the tank was flat-bottomed, and this shape is not favorable to floating off the bottom of the "pond" made for it. But "there are other ways of killing a cat besides choking it to death with butter." The little matter of flotation was started by pumping air into the tank until the bottom bulged downwards and let the water under it. It was then an easy matter for men with ropes to haul and turn the tank. Piles previously placed in position limited the motion and aided in leaving the tank exactly where it was wanted. The internal air pressure was kept up until the tank was in its new place, to prevent the upward water-pressure from dishing the bottom upwards; this upward pressure naturally amounted to about 0.26 ton per square meter, or say 52 lbs. per square foot. Naturally, a calm day was chosen for the "fitting," as the Scotch call a moving.

The operation was successful and had the merit of being not only original, but economical, which is more than can be said of much gasometer and oil tank work.

ROBERT GRIMSHAW.

* * *

DROP HAMMER FOUNDATIONS.

Editor MACHINERY:

Jones wrote me asking about a foundation for his steam hammer. I sent him one or two clippings and later he wrote me that the makers of the hammer had sent him prints and he had followed them. The next time I saw my friend Smithers we talked about hammer foundations. Smithers has four or five drops, which he is running day and night. He interests me. He has ideas of his own about things. At this time he was putting down a foundation for a new 1,200 pound drop. The foundation is made as per accompanying sketch, Fig. 1. He allowed it to harden about three or four weeks before setting the hammer in place.

Just across the passageway is another 1,200 pound drop which had been put in several years ago and had cracked the base. Pending the arrival of a new one, this base was in use, heavily clamped and bolted together. He showed me the blue print of the foundation, which had been put down under this hammer and it is reproduced in Fig. 2. This was the practice of a first-class concern several years ago. Now they recommend the solid foundation as in Fig. 1. This is interesting as an example of the growth of the anvil principle.

On the next visit Smithers had both hammers in operation. The hammer with a solid foundation was coming down with a solid "chunk" which indicated that no lost energy was taken up

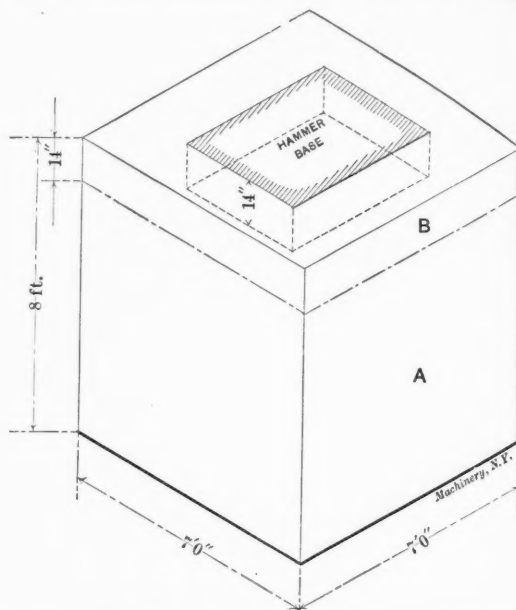


Fig. 1. A, made of concrete consisting of 1 part mortar (1 cement, 2 sharp white sand), 3 parts 2-inch broken stone. Concrete tamped every 6 inches until water appeared on top. Base A allowed three weeks to harden and then dampened on top. Hammer base placed in position and cement mortar 14 inches deep poured in to keep base in place. B made of 1 part cement, 1 sharp white sand.

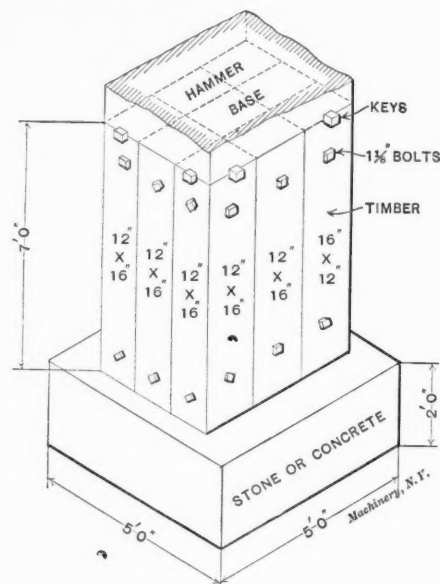


Fig. 2.

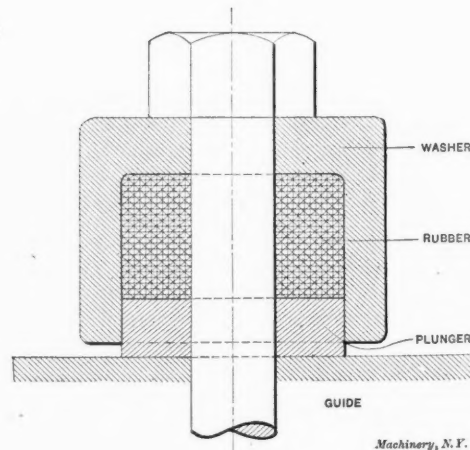


Fig. 3.

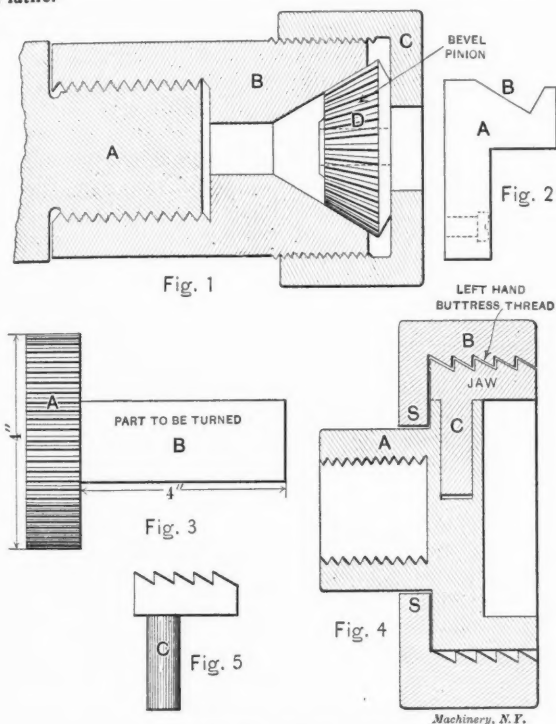
by springy or elastic foundations. The other hammer, while doing good work, did not give out the soul-satisfying note of the new one. Then Smithers began to tell of his troubles with the bolts which hold the guides to the base. They kept breaking off.

Said he had been figuring it out and had come to the conclusion that the anvil or base had to take up the energy of the blow and naturally tried to get away from it. The guides and running gear were not in so much of a hurry and held back a little. This caused a heavy stress in the bolts which had to bring them on. He called it the inertia of the parts or something like that. His remedy was to place an elastic substance between the bolt heads and guide flanges, so that no matter how hard the nuts were set up there would still be a slight give which would prevent the heavy strain on the bolts. The device is shown in Fig. 3. The counterbored washer with the plunger fitting the same prevents the rubber from being squeezed out under pressure and in fact almost makes of it an elastic fluid. One cannot ordinarily set up the bolts so hard that there will not be a slight yield in the rubber. This he thinks will stop the "snap-the-whip" business that has been going on with the bolts. He has had them on one of the smaller drops for three or four months and is fitting up the others as rapidly as possible. S.

THREADING TAPS WITH SHRINKAGE ALLOWANCE—CHUCKS FOR GEARS.

Editor MACHINERY:

In the How and Why columns of the April issue, question No. 44, "Subscriber" asks how to thread a tap so that it will have the right pitch after hardening. There is a toolmaker less than a hundred miles from here, who thought he struck a scheme. He made some long taps and found they had shrunk. The screws to work in the nuts tapped by these long taps are cut in the lathe.



Chucks for Holding Gears.

To make the pitch correspond he moved the tail stock over, then set the taper attachment to correspond. To his consternation and the amusement of the machinist he only made the matter worse. If "Subscriber" will thread the tap by this plan, he may overcome the trouble caused by shrinking, as it is possible to thus obtain a slight variation from the correct lead sufficient to overcome the shrinkage.

As we have a great many small cast bevel pinions to bore out, I made some special bell chucks like those in Fig. 1. The body B screws on to the spindle A and is bored out to fit the pinion. There is a nut C that fits over this end of the chuck to screw up against the pinion and force it into the taper. These chucks more than pay for themselves in time saved in chucking. The pinion will center in the chuck very true. Perhaps a better way would be to get a three-jaw universal chuck, one of the kind with a removable jaw like the Westcott, and make a special jaw like that shown in Fig. 2; then you would need a separate set of jaws for each size of pinion. Sometimes toolmakers find it a great deal easier to make tools like these in the shop than to induce their firm to buy them, even though they may cost a

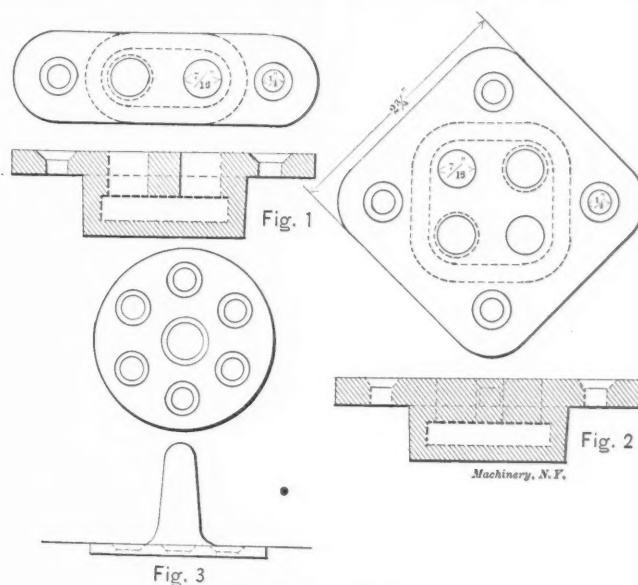
little more than the ready-made. We make a little spur pinion with a cast and turned shaft like Fig. 3. Several thousand are made in a year. I found it a very easy matter to center the end of the shaft, but the other end was more of a job. A belt chuck was first made, but was found very unsatisfactory on account of the variations of the castings. Then three set screws were put in, but this proving too slow, I made a chuck as follows: The bell chuck was used for the body B, Fig. 4. A nut to fit over this and fit snug on the body at S S was also made. In this a left-hand buttress thread was cut. In addition to this, three jaws like in Fig. 5 were provided. I cut three notches in the body of the belt chuck and drilled holes for a guide on the jaws. I fastened these jaws in the body and bored the inside of them to fit the casting to be held and cut the thread on the outside to fit the thread in the nut. This works very satisfactorily, but no better than a three-jaw universal chuck. W. A. BRIGHT.

Decatur, Ill.

RAP AND DRAW PLATES FOR PATTERNS.

Editor MACHINERY:

I have been very much interested in your letters from practical men, but regret that we do not get more hints on wood work and pattern making. I note with interest your reply to J. T. B. in the January number, page 159; also S. M.



Rap and Draw Plates.

Preston's suggestions in the March number, page 219, about draw plates. In my seventeen years' experience as pattern maker at the Terre Haute Car and Mfg. Co., of this city, I used the kinds of plates described until I found that the sand in the bottom of the hole would accumulate and the moulder would screw in his draw iron on top of it until he would either lift out the plate or burst the pattern out below it. This experience drove me to make a rap and draw plate like Fig. 1. The chamber communicates with the holes to allow the sand, when crowded from one hole, to escape to the other. One hole is tapped to draw by and the other left plain as rap in. Then I found that the moulder would soon rap in the threaded hole and spoil his thread, and that I often needed a heavier plate. So I made one like Fig. 2, with the same chamber feature connecting all the holes and also protecting the pattern from the pressure of the sand under the draw-screw. This works well, but lasts only four times as long as the first, as they will soon rap in all the holes. What will men do then? Just drive their old draw spike (the greatest pattern destroyer in the foundry) deep into the pattern to draw it by and keep at it until the pattern is ruined or you catch them at it and put in a new plate. To prevent this I made a draw plate with a handle on it to rap against, so that every pattern would have a smooth handle to draw it by. See Fig. 3. This one I was persuaded to get patented, which seems to have killed it, though I have tried to push it on the market at a very low price as you see by list enclosed. It is not the purpose of this letter to advertise this little pin of mine but to add my experience to that of the many who have so kindly given us theirs.

Terre Haute, Ind.

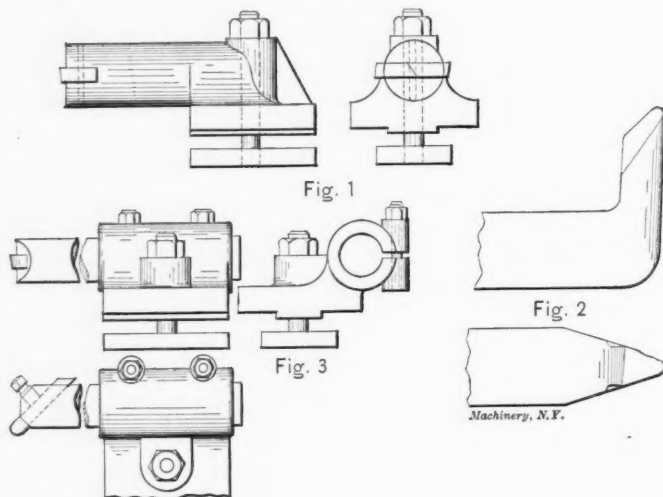
E. T. WIRES.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TURRET TOOL-MILLING MACHINE CHUCK.

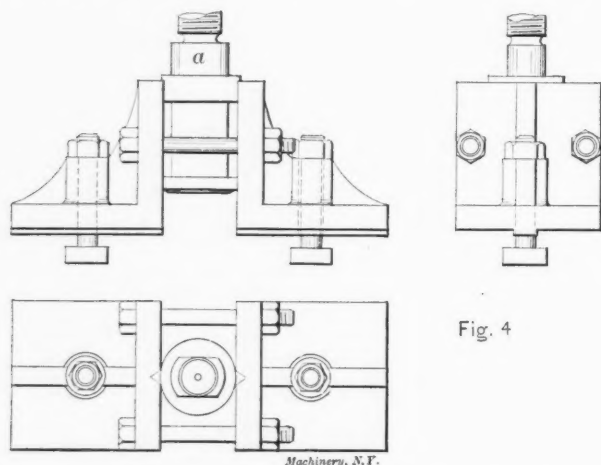
W. F. Long, San Antonio, Tex, says: I send you the accompanying sketches of several shop devices which I will endeavor to describe in as few words as possible. Referring to Fig. 1 we have what I call a "poor man's" turret tool. This is used in the saddle of a common engine lathe by having one for each operation that is to be performed. It is small work to



make the change. Fig. 2 illustrates a tool which, I believe, has more good points than others now in use, still I have never found one in any shop during my extensive travels. Among the good points of this tool are $\frac{1}{2}$ the amount of steel saved; $1\frac{1}{2}$ times more wear than with other tools, which also means that amount of blacksmith work saved; a much greater top rake, which makes a free cutter, and a less front rake. It will, therefore, carry a heavy cut. Steel $\frac{3}{4}$ " thick is abundantly strong for any class of work on a 21" lathe, and steel of $\frac{7}{8}$ " to 1" thickness will be required for larger lathes.

Fig. 3 shows an extension boring tool which, I believe, needs no explanation other than that the tool is held in position by the friction caused by clamping the two studs in the shell. This permits the bar being revolved to get the tool to the proper position. For a 24" lathe, a bar of $1\frac{11}{16}$ " made from shafting 24" long, will answer most requirements, as it can be adjusted to the length desired.

Fig. 4 is a device which has many good features. The pin outlined gives a good idea of what can be accomplished by its



use. Although it is quite a simple job to mill such a pin, many would spend much time trying to decide the best way to hold the same. This tool is quite useful with lathe, planer, drill-press and milling machine, as its capacity is limited only by the distance between the bolts.

BALANCE WEIGHT FOR TURNING CRANK-SHAFTS-CENTERING DRILL.

O. A. R., Mattoon, Ill., sends in the following kinks: He says, "I had some heavy engine center cranks to turn, which, when it came to turning the wrist pins, were found so heavy that weight enough could not be put on the face-plate to balance. So I had centers made as in the sketch, Fig. 5, and clamped the weights on each end and found it much better than balancing altogether on the face-plate."

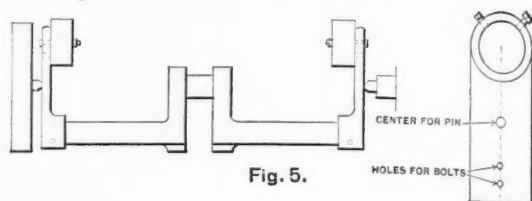


Fig. 5.



Fig. 6.

In turning a taper, where the tailstock is set over, if the center drill be ground with a concave lip, as shown in Fig. 6, it will give better results, as the work will run truer when the tailstock is changed or set to cut straight.

TAP WRENCH.

H. J. Bachmann, New York, says: "I send you a few suggestions which have come under my observation during my varied experience. If you own a 2-inch micrometer do not let it lie around an Almond chuck. I had a brand new one once and it looked so much like the spanner, which is generally missing, that a green "machinist" inserted the anvil in the chuck hole, gave the barrel a few thumps with his hand and the drill was fast and the micrometer broken."

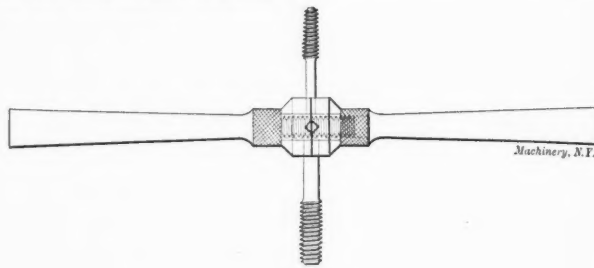


Fig. 7.

"The sketch Fig. 7 is that of a tap wrench which will hold four taps at once and which I think is very handy where several sized holes must be tapped in the same casting. The center blocks or tap holders may be accurately milled out with a 45° cutter and should be of hardened tool steel. The handles are made the same as an ordinary tap wrench."

DRILL WITH DIVIDED POINT.

Harry M. Johnston, McKeesport, Pa., says: "Having had occasion to bore an 1" hole in a solid steel forging, I attempted to run a $\frac{3}{4}$ " drill through it preparatory to boring. Everything went O. K. until the hole was drilled with the exception of about

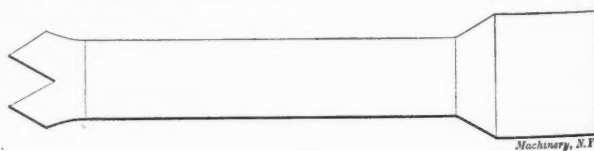


Fig. 8.

$\frac{3}{16}$ ", when the drill refused to cut. Upon examination I discovered a small, very hard spot in the center of the end of the hole. I took the drill, the point of which was fractured, and ground a conical groove in the center, as shown in Fig. 8, and it cut that hard spot out easy as a pie."

CENTERING FORK.

J. Suess, Chicago, Ill., says: "Enclosed you will find a sketch, Fig. 9, of a fork for use in a lathe for centering large numbers of small round stock without the use of a dog or center punch, which is, consequently, a great saver of time. This fork does the driv-

ing, and allows the use of the square center in the ordinary way. A is turned to fit the lathe spindle, C is projected beyond the nose of the spindle and is turned and bored to about the same bevel as in the sketch. B is an end view when C is milled out. D shows an end view of one of the prongs or forks which are

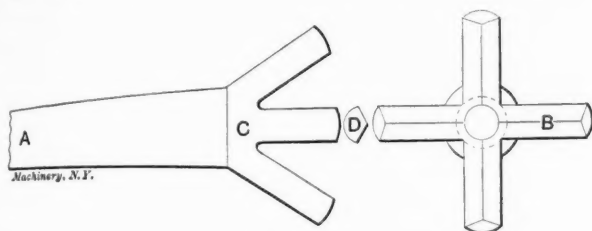


Fig. 9.

milled so that each one of the four has a sharp corner on the inside for biting into the work and driving it. Those prongs ought to be twice as heavy as shown in the sketch. In using this tool there is no need of stopping the lathe for placing the work in or out."

TAPPING RIG FOR DRILL PRESS, ETC.

Frank Greiner, New York, says that Fig. 11 represents a cheap home-made tapping rig attached to a drill press, and Fig. 10 a makeshift substitute for a following steady-rest, for turning long shank nut-taps, etc. A in Fig. 11 is the spindle of the drill press; B is the stationary sleeve, serving as bearing for the spindle; C C

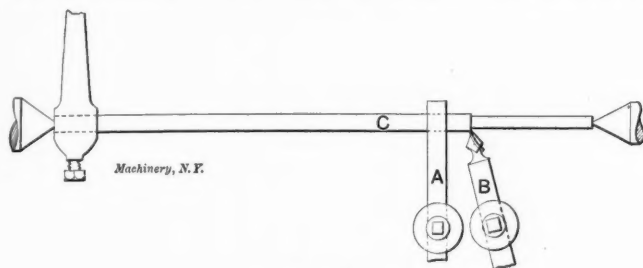


Fig. 10.

is the cast iron frame, in two parts, the upper one fitted and clamped to B; D D are the studs (four of them) holding C C together; E is the machine steel shank or spindle carrying the tap; F, G, H, I and J are gears; K is a spring tempered pin through E, which engages, or is engaged by L in F "going in," and by M in I "backing out"; L, M are also spring tempered pins

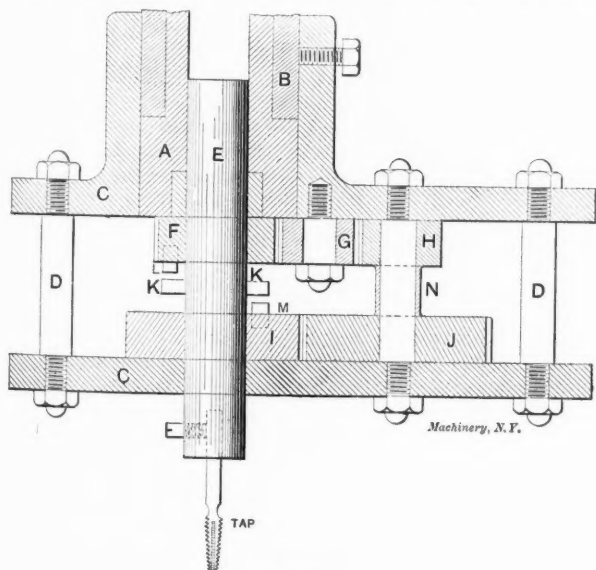


Fig. 11.

in gears F and I. E, which is loose fitting in A, F and I, is forced upward, when tapping, and being engaged through L and K it revolves in the direction of spindle A, till the tap is through, or the stop collar on top of the spindle compels L and K to disengage. When "backing out," the whole attachment is forced away from the work and K is engaged by M in I, which runs in the opposite direction, owing to the interposed gear G.

Fig. 10 is self-explanatory. C is the stock to be turned down,

A is an ordinary lathe tool put in the tool-post backward, while B is the regular diamond point tool. As will be seen, two tool-posts are necessary. Tool-post No. 1 holds the steadier, which has a hole drilled through it to fit the stock snugly, while the diamond point tool occupies tool-post No. 2. It is essential to have both centers align perfectly and to center the stock carefully. This being done, the cut is "set," and plenty of oil is fed on the work. The shank may be turned down in one cut without any chattering.

* * *

AT THE CINCINNATI MEETING*.

REPORT OF THE PROCEEDINGS AT THE RECENT CONVENTION OF THE A. S. M. E.

There is no city more appropriate as a meeting place for the American Society of Mechanical Engineers than Cincinnati. It is the great machine-manufacturing center of the country, particularly in the line of machine tools, which, because of their use in machine construction, are of greater interest to a larger number of engineers than any other class of machinery. The shops of Cincinnati are for the most part new and modern and are good examples of the best practice. Cincinnati itself is the center of a large manufacturing district and is easily reached from most of the manufacturing cities of the West. As might be expected, many Western engineers and manufacturers were present who are seldom seen at the meetings in New York and other Eastern cities and thus the influence of the organization was broadened and the acquaintance of many of its members widened. On the other hand, many well known engineers who are usually present and contribute to the discussions were absent, and the discussions suffered accordingly.

With regard to the discussions it should be said that they were disappointing. Under the rules of the society the papers presented are first read by their authors, either in full or by copious extract as preferred, and then follow the discussions. When the papers are long, much time is consumed before the opportunity for discussion is reached and the main object of the meetings—that of getting together and interchanging ideas by a free discussion—is defeated. The present practice curtails the discussions, makes the meetings long and tiresome and when, as was the case at Cincinnati, the weather is warm, the members are tempted to devote more time to social matters than to the more important professional duties. All the papers are now sent to each member of the society several days before the meetings, so there is ample opportunity for all to become familiar with them without the customary reading. With this reading omitted and with more effort towards drawing out discussions from members of the society, particularly upon the more important papers, the sessions would not only be of greater interest, but the value of the published reports of the meetings would be greatly enhanced.

The first session was called to order by President Charles H. Morgan, in the convention hall of the Grand Hotel on Tuesday evening, May 15. An address of welcome was delivered by the Mayor, and in his response President Morgan impressed the fact that the chief aim of the mechanical engineer should be to render service, illustrating his point by a personal incident that happened over forty years ago. At that time Mr. Morgan was called to Cincinnati to install some machinery and as some parts had become broken in transit he went to the shop of Latta Bros. for repairs and assistance. "To these men," he said, "backed by Miles Greenwood, is due the conception, construction and introduction of the first automobile steam fire engine of America. Seeing one of these engines put out a fire made a great impression upon me, and, when it was decided to hold our spring meeting in this city, I looked forward to taking these gifted men by the hand, but I find they have both passed on. Cherish the memory of these men who did so much to make your homes and the homes and property of our country more secure from the ravages of fire, for in so doing you will encourage some young mechanics or engineers who may be hungry for recognition or appreciation." The evening closed with an informal reception and smoker.

* On page 297 will be found abstracts of most of the papers read at the Cincinnati meeting, and in what follows brief mention is made only of the more interesting discussions and events that occurred during the three days of the convention.

Wednesday Morning Session.

The first professional paper on the list was that on the value of a horse-power, by George I. Rockwood, which was here brought up for discussion a second time, this being a paper that was presented at the last New York meeting. In Mr. Rockwood's temporary absence the next paper upon "Hot Water Heating from a Central Station," by H. T. Yaryan, was taken up. In the discussion, F. N. Jewett, of Chicago, contended that storage tanks for systems of this character were not of great utility because of the enormous size required to supply heat for any considerable length of time. Fred A. Waldron advocated the vacuum system of steam heating in preference to heating by hot water and cited the system in use at the Yale and Towne works, which runs on 13 pounds absolute pressure, or 4 inches of vacuum, and all the condensation is returned to the boiler. In Mr. Yaryan's paper were given 14 reasons why the author preferred hot water to steam heating and to several of these Mr. Waldron made reply in detail, showing that the objections raised did not prove valid in the installation mentioned. William F. Mattis contributed an amusing communication in which he disputed the sweeping claim that hot water heating would be the system of the future. He said that a complete system should supply heat for cooking and for power as well as for heating and that fuel gas as a by-product of coke, natural gas and the culm heaps of the coal regions deserved recognition as future possibilities for extended heating systems. He thought gas conveyed in pipe lines might be as profitable as coal conveyed by rail. In reply to the discussion Mr. Yaryan said that he advocated storage tanks simply to take the excessive heat from the exhaust at certain times during the day when the demands for power were greater than the demands for heating. He also held that the vacuum system, while practicable for factories, was not so for heating, because of the difficulty in collecting and returning the drip. He stated also that wrought-iron pipe withstands the corroding action of hot water better than steel pipe and that distilled water, such as is obtained from the drips in a steam pipe, is very destructive in its action upon both steel and iron pipe.

The next paper was by Prof. Aldrich upon "Systems of Electric Transmission of Power," and brought out very little discussion. Such opinions as were expressed were mostly in favor of the induction motor, largely because of the small amount of care required. One speaker suggested that as many as possible visit the Bullock Electric Shops in Cincinnati, where all the machines are operated by independent direct-current motors. These motors are wired in such a way that no resistance coils are necessary for varying the speeds of the motors. There are four currents of different voltages available for each motor and any two or all of them can be combined, or the motor can run with any single one, thus giving a great variety of speeds, as a result of the different voltages that can be obtained, either singly or in combination.

"The Design of Speed Cones," by J. J. Guest, and one or two discussions upon the paper, were read by title only because of their mathematical character.

Mr. Rockwood's paper was finally considered before the close of the session, Mr. Rockwood then being present. At the last meeting of the society Mr. Rockwood introduced a resolution to the effect that a committee be appointed to investigate the question of water power privileges with a view to formulating some general principles that would enable an engineer to determine the value of a water power confiscated for public use. The council held that as both legal and commercial points were involved in such a question it was without the jurisdiction of the society, and the gist of the discussion at this meeting was upon this point. This view was supported by J. M. Smith in a written discussion. Mr. Rockwood contended that in its broad sense engineering should include as much of commercial law and practice as an engineer would ordinarily meet in his daily duties and that the subject came as much within the scope of the society's work as the subject of engine tests, which is now being considered by a committee.

Wednesday Evening Session.

On Wednesday evening was the second session for reading and discussing papers. The first paper, by Dr. Thurston, brought out a few words of approval from Mr. Rockwood with regard to the use of separators in connection with reheaters. The sec-

ond by Prof. Magruder, upon "The Gas Engine Hot Tube as an Ignition Timing Device," was simply a record of a large number of experiments and not of a character to allow discussion of importance, and the greater part of the evening was devoted to the paper by N. O. Goldsmith, upon the "Water Softening Plant of the Lorain Steel Co.," and that by M. P. Higgins upon "The Education of Machinists, Foremen and Engineers." The first of these two papers drew out a valuable letter from A. A. Cary, New York City, giving a resumé of water softening methods. He believed that chemical treatment is the most successful and flexible process and that boiler compounds are suitable for only a few special cases. In the matter of treating water to remove scale-forming elements we are far behind European practice. One writer advocated the more rapid treatment of water by using higher temperatures in the heater, which would tend to throw down more impurities in a shorter space of time. He would treat the water with soda ash only, since this will effect the precipitation of the impurities, although it will not make them insoluble. In reply to a question as to the cost of water purifying at the Lorain Steel Works, Mr. Goldsmith stated that the chemicals and labor amounted to about $2\frac{1}{8}$ cents per 1,000 gallons and that while the plant cost 30,000 dollars, one of like capacity, to handle 1,200,000 gallons per day, could be built for 12,000 dollars.

The discussion of Mr. Higgins' paper was in general favorable to his plan for training boys to become useful workmen upon leaving school or to enter a higher technical school upon graduation as they desire. He believes in raising the level of a large number of men rather than devoting all education to raising a few to a very high plane, leaving the rest to shift for themselves. He cited the case of a boy of 14 years who has completed the grammar school course. The boy is undecided whether to go to work or to enter the high school. His father thinks he is able to support the boy four years more, but then is confronted with the idea that at the end of that time the boy will still be unable to earn his living through any preparation he may have had at school and it is this condition of affairs that Mr. Higgins wishes to change. One speaker made a strong plea for the education of the working mechanic and told of his struggles to obtain a Whitworth Scholarship in England, as an illustration of the difficulties that young mechanics who want an education often have to contend with. William Kent expressed the idea that if Mr. Higgins' half-time school should be fairly introduced to supplement the work of the technical college, it would be found a necessary adjunct of the present educational system and that its methods would become quite generally in vogue.

Closing Session on Thursday.

Mr. Herschmann's paper upon the Automobile, although upon a new subject, contained little that any one attempted to criticize. He had worked out his plans with so much care that his conclusions appeared to be very well justified. One speaker had investigated the subject quite thoroughly and had come to the conclusion that all four wheels of an automobile should be driven by the motor and should also be used for steering. This would enable trucks to move sideways as well as forward and back in a circle, and in spite of the mechanical complication he thought a good mechanical solution possible. It was brought out by E. F. Du Brul that because of the steep grades in Cincinnati steam carriages were the only ones that had so far met with success in that city. Heavy trucking is difficult and expensive and he believed a successful steam truck would be received there with favor. Another point mentioned by E. W. Roberts was that gasoline engines can now be made to run with a wide variation of speed by changing the point of ignition of the gas in the cylinder and carriages fitted with them require only two sets of gearing, one for hill climbing and one for running on the level.

At this session the group of papers upon engine tests by M. E. Cooléy, Prof. Goss and E. H. Foster, which are referred to elsewhere in this issue, were read in succession. The closing paper, by B. C. Ball, upon cylinder proportions for compound engines, was also grouped with these, and all four papers were then discussed briefly. As time was getting short, there was but little discussion. One printed discussion was submitted illustrating a simple compensating device for direct-acting steam pumps, which was intended to do the same work as the well-known Worthington compensating cylinders. F. A. Halsey criticized a

method used in the test reported by Mr. Cooley in determining the pump friction. This method was by indicating the steam and pump cylinders and as the total power of the engine was large, a small percentage of error in the indicator might indicate a considerable difference between the steam and water ends of the pump which would wrongly be attributed to friction. He also criticized the placing of springs in the indicator cylinder, where they would be subjected to temperature conditions.

Following the papers there was a brief topical discussion of the preservation of penstocks, in which D. J. Lewis gave as his experience that Bitumastic enamel, an English preparation, was far superior to anything he had used.

The arrangements made by the local committee, J. B. Stanwood, chairman, were so complete and the hospitality extended by the members of the local society and other residents identified with the same interests, was unstinted. The thanks of the society for these many attentions were extended to their hosts and the many favorable comments that were made showed that the formal resolution of thanks was sincerely felt by those who were so fortunate as to be guests upon this occasion.

On Wednesday afternoon, a notably pleasant trip was made for several miles down the Ohio River in a specially chartered steamer. Before the return a stop was made at the immense Addyston plant of the United States Cast Iron Pipe and Foundry Company.

Thursday afternoon trips were made by part of the members to the Cincinnati Oyster and Fish Company's refrigerating plant; and by others to the shops of the Bullock Electric Mfg. Co., where lunch was served.

On Friday the day was taken for a trip to Dayton to inspect the works of the National Cash Register Co. Every opportunity was given to investigate the well-known industrial features that the management of this company have adopted. These were fully described and illustrated in two articles published in the issues of MACHINERY for September and October, 1898. Upon arrival a group picture was taken of the guests and they were then conducted to the lecture hall where stereopticon views were shown. The last view was from a negative made but a short time of the group, much to the surprise of every one. The guests were then taken through the works and refreshments were served.

The plan of personally conducting visitors to points of interest about the city was adopted and the ladies who were present particularly enjoyed this arrangement.

On Thursday night the reception and dance at the Hotel Alms was one of the most enjoyable occasions of the kind at any of the meetings of the society.

* * *

MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—8.

BALL AND IRREGULAR TURNING.

W. H. VAN DERVOORT.

With the regular tools and feeds on the engine lathe, plane, cylindrical and conical surfaces are readily machined. If the sur-

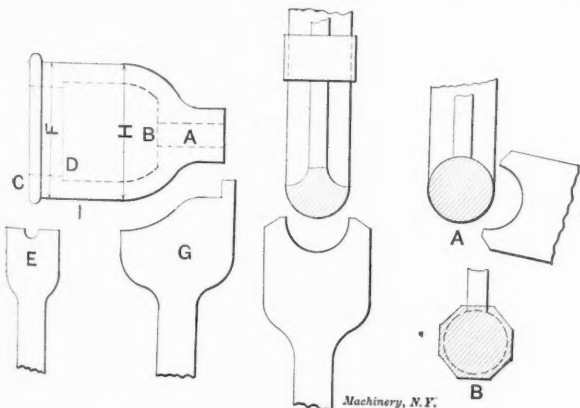


Fig. 66.

Fig. 67.

face is spherical or of irregular outline, a forming tool or some special attachment must be used on the lathe to produce the required outline. If the work is of circular section, the forming tool can usually be used to excellent advantage, as illustrated in

Fig. 66. In this case the tail-stock cap shown in the figure is first chucked, bored at A, faced at B and threaded at D. It is then placed on a threaded mandrel and driven on the centers. The forming tool E, which is secured in the ordinary tool-post, forms the bead and is set in until the proper diameter at F is obtained. The tool G, held in like manner, forms the hub and rounded end of the cap, the tool being set in until the diameter at H is equal to that at F. A common tool is then used to produce the cylindrical surface I. If the length I is short it would be possible to combine the two forming tools into one. As the

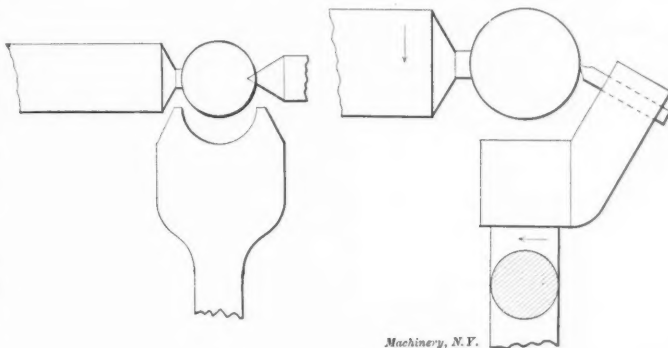


Fig. 68.

Fig. 69.

cutting edge is a long one it is, in any event, desirable to rough off the scale and true up the casting before applying the forming tools. This can be done by operating the regular feeds by hand. If the work does not run true when the forming tool is set to the cut, it will be difficult to produce satisfactory results, as the spring of tool and work will vary at different points in the revolution. The length of cutting edge that can be employed depends in any case upon the stiffness of the work and the rigidity of the lathe in which the work is to be done. Another illustration of this system of forming is shown in Fig. 67. Here the

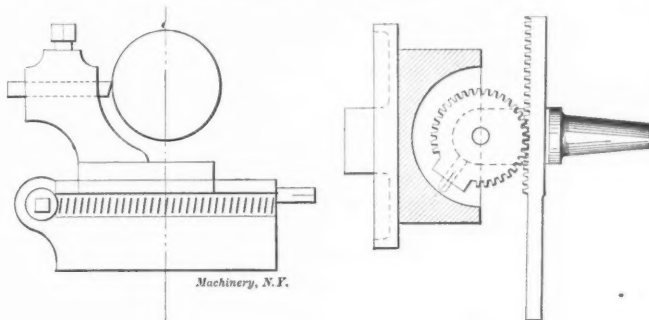


Fig. 70.

Fig. 71.

rim of a hand wheel rounded by the forming tool is shown. If the section of the rim is a full circle, as at A, two settings of the tool are required, one of which is illustrated in the figure. It is here even more important than in the example shown in Fig. 66 to first rough the stock until it runs true, as the heavy cut of the forming tool will otherwise spring the work so that it will not run true when finished. For roughing out the rim a side-cutting tool can be used to good advantage, setting it at different angles to produce a section similar to that shown in the figure at B. If the tools are carefully made and kept in good condition, very satisfactory results can be obtained upon a wide range of work, similar to the above examples.

The tools should be so made that they can be sharpened by grinding from the top surface. If the tool is carefully made and the scale removed from the stock, it will do a larger amount of work before dulling materially. Forming tools of this character are not expensive to make, and, when any considerable amount of similar work is to be produced, will pay for themselves very quickly.

The tool shown in Fig. 67 may be used for turning balls from stock held between centers or in a chuck, as shown in Fig. 68. If the stock is held in the chuck, the ball will not be disfigured with the center bearing. A small tip will, however, remain where cut from the body of the stock. In forming balls in this manner it is necessary to caliper the diameter carefully, advancing the tool only far enough to produce a true sphere. This method will be found very convenient in the forming of balls on the ends

of handles, the ball in such cases not being cut from the body of the stock, and perfect spheres not being necessary. In Fig. 69 is shown a simple ball-turning device. The shank A of the cutter holder is round and fits in a suitable bearing which is clamped to the tool block. On the outer end of the shank is secured a long lever or preferably a worm and gear mechanism for rotating the cutter head and tool to the work. Although a truer sphere can be obtained with this device than by the use of the forming cutter shown in Fig. 68, the surface will not be as smooth as with the latter. The more elaborate device shown in Fig. 70 is better adapted to the turning of larger balls than either of the methods above referred to. While this attachment can be pro-

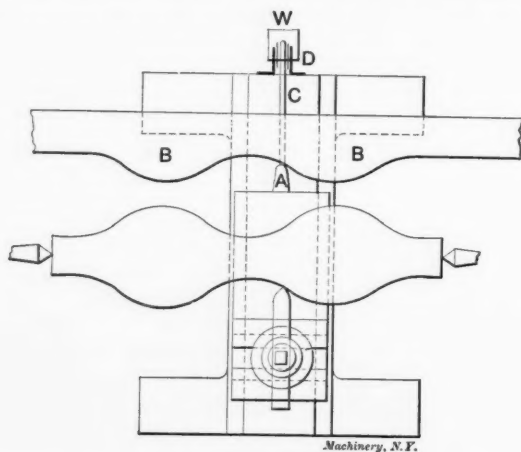


Fig. 72.

vided with a shank and held in the tool-post, it is much more rigid when secured directly to the tool-block or in the place of the compound rest. The construction of the device is clearly shown in the figure. In order to produce a true sphere the center of rotation of the cutter-carrying disc must be exactly under the center of rotation of the work, and the distance of the point of the tool from the center of rotation then determines the radius of the ball. By setting the tool with its point past the center of the disc and bringing the center of the disc back from the center of rotation of the work a concave section can be produced in the work, the character of the section depending upon the relative position of centers and tool point. With work held in the chuck and the center of the disc under the center of rotation of the work, it is possible to produce on the end of the work either a convex or concave surface depending on whether the point of the tool is back or ahead of the center of rotation of the disc.

A convex or concave surface can readily be turned with a tool held in the common compound rest, the only difficulty being in the control of the feed. When the cuts are light, however, satisfactory results can be obtained by moving the rest by hand, having its clamp bolts tightened just enough to steady the motion.

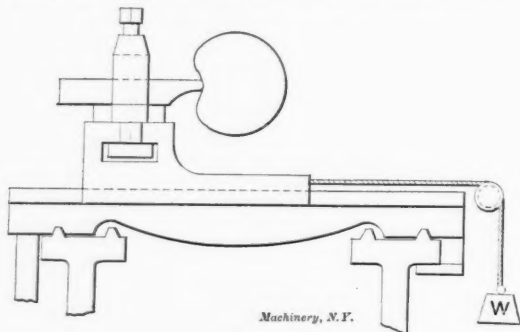


Fig. 73.

The boring of spherical sockets can readily be accomplished by means of the special attachment shown in Fig. 71. The small gear is mounted on the flattened end of a stub center which is fitted to the tail spindle bearing. The cutting tool is secured in the face of this gear and the gear caused to rotate by means of the rack which is carried in the tool-post and actuated by the regular cross-feed on the lathe. The cutting edge of the tool must be set at the height of the center.

In cases where the outline is irregular and too long to be conveniently produced with the forming tool, a common tool may be made to do the work, its motion being controlled by a

guide having the same outline as the one desired and controlling the tool on the taper-attachment principle. The general arrangement is shown in the top view of a lathe carriage, Fig. 72. In this case the slide is disconnected from the cross-screw. BB is the guide which is secured to the bed of the lathe and independent from the carriage. The finger A is secured to the slide and bears against the guide B B. A cord C is attached to the slide, passes over the pulley D and carries the weight W which serves to hold the finger A to the guide at all times. The point of the cutting tool must travel with the finger A, and, tracing the outline of B B, produce the same outline on the work. In this arrangement the tool is usually set to the work by adjusting it through the tool-post. A threaded adjustment in the finger A makes a good adjustment for the finer tool settings. This method is applicable only when the cross-section of the work is round.

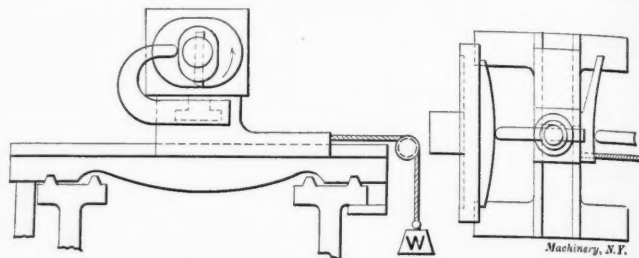


Fig. 74.

Fig. 75.

If an irregular cross-section is required, a different arrangement involving the use of a pattern or dummy is generally employed. The dummy is a pattern of the same cross-section as that required on the work and is mounted either on the same axis as that of the work rotation or on a separate axis so geared as to make the same number of revolutions as the work. When the work is short and both it and the pattern can be mounted on the same axis, the former method is, owing to its simplicity, preferable. In Fig. 73 is illustrated the former method. As in Fig. 72, the cross-feed screw is disconnected from the cross-slide and a weight provided for holding the finger against the pattern B, which rotates with the work. A second tool-post, back of the one carrying the finger, holds the tool that operates on the work. It is evident that the motion of tool point and finger is the same and that the outline of the work will be the same as that of the pattern. If the two tool-posts cannot be set sufficiently far apart to allow for the required length of cut, the finger can be carried on a suitable bracket secured to the side of the tool-block. It is quite possible by careful adjustment to start the cut with the use of the pattern and allow the finger to lead from the pattern on to the work, thus enabling a long cut to be made with a short pattern. A careful readjustment of the finger is required for each cut in this case. It is not necessary that the pattern be of the same size as the work section, as it is frequently desirable to make it of a different size.

It is quite possible to adapt the method of Fig. 73 to internal work. In Fig. 74 the work is secured on the tool-block and the pattern on the boring bar. In this case the work moves with the pattern instead of the tool. The example shown illustrates the method of boring an elliptical hole. By using a movable head boring bar a thin pattern is all that is required. As a wide range of patterns can be used many forms of cams can be produced by the above method.

The same method shown in Fig. 72 is applicable to face work on stock held against the face plate or in the chuck. In this case the weight is placed at the end of the bed, the guide is secured to the cross-slide and the finger to the tail-stock, all as shown in Fig. 75. Many outlines can readily be produced in this manner. The tool is operated by the regular cross-feed mechanism.

* * *

In his interesting article upon the genesis of machine design in the March number, Mr. W. H. Sargent spoke of the slide which moves up and down in the handle of a monkey wrench as resembling a toy monkey, and thereby drew an analogy. To this Mr. H. E. Madden writes: "The wrench is not named from this, neither is it so called because it is a handy thing to 'monkey' with. The right name is 'Moncky.' Charles Moncky, the inventor of it, sold his patent for \$2,000 and invested the money in a house in Williamsburg, Kings County, N. Y., where he afterward lived."